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SPECIATION IN ANCIENT LAKES

(CONCLUDED)

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SPECIATION IN THE AFRICAN RIFT LAKES

ONLY two lakes existing today resemble Baikal in both morphology and magnitude. These are the African Rift Lakes, Tanganyika and Nyasa. As the fauna of each is known to include species flocks, these lakes are also of immediate concern to us.

Description of Lakes Tanganyika and Nyasa

Like Baikal, Lakes Tanganyika and Nyasa each occupy tectonic troughs and all have many similar features. All are very long and narrow. The long axis of Tanganyika measures 650 km., whereas that of Baikal is 675 km. Their areas and therefore their average widths are practically identical (Halbfass, 1928). Nyasa is shorter, 580 km. in length, but about as wide, with an area of 25,000 sq. km., according to Gillman (1933). Baikal, Tanganyika, and Nyasa are respectively the seventh, eighth, and ninth largest in area of the lakes of the world (Halbfass, 1937).

A bathymetric map of Tanganyika was published by Stappers in 1914. Rhoades' map of 1902 is the only one available for Nyasa. (Stappers' map is reproduced in Beauchamp, 1939, and in Poll, 1946.)

In Tanganyika the maximum depth which has been found is 1435 m., proving this to be the second deepest lake in the world. Tanganyika is separated into two major basins by a ridge joining the large peninsulas jutting into the middle part of the lake. The position of the ridge is indicated by the arrows in Fig. 6. Dr. Max Poll, of the Congo Museum, Tervuren, has graciously informed me in personal communication that echo-soundings made by Dr. A. Copart, oceanographer of the recent Belgian expedition to Tanganyika, indicate that this ridge between Kungwe and Albertville has a mean lower depth ("profondeur moyenne inférieure") of 500 m. At one of Stappers' soundings the ridge was within 136 m. of the present surface. The southern basin is the larger, and the maximum depth was found somewhat south of its middle. The maximum depth recorded from the central basin is 1277 m. The greater part of the bottom of the third, much smaller basin which forms the northern tip of the lake is about 200 m. below the surface. The only major irregularity in the present Tanganyika coastline is the J-shaped Ubwari Peninsula which juts from the west shore at the northern end of the lake and separates the northern from the central basin. The long arm of the peninsula runs northward parallel to the shore and encloses the relatively shallow (to about 200 m). Gulf of Burton.

Nyasa is not as deep as its northern sister, ranking as fourth deepest of the world's lakes, with a maximum depth of 706 m. (Halbfass, 1937). Most of the bottom in the southern half of Nyasa is between 100 and 350 m. below the surface,

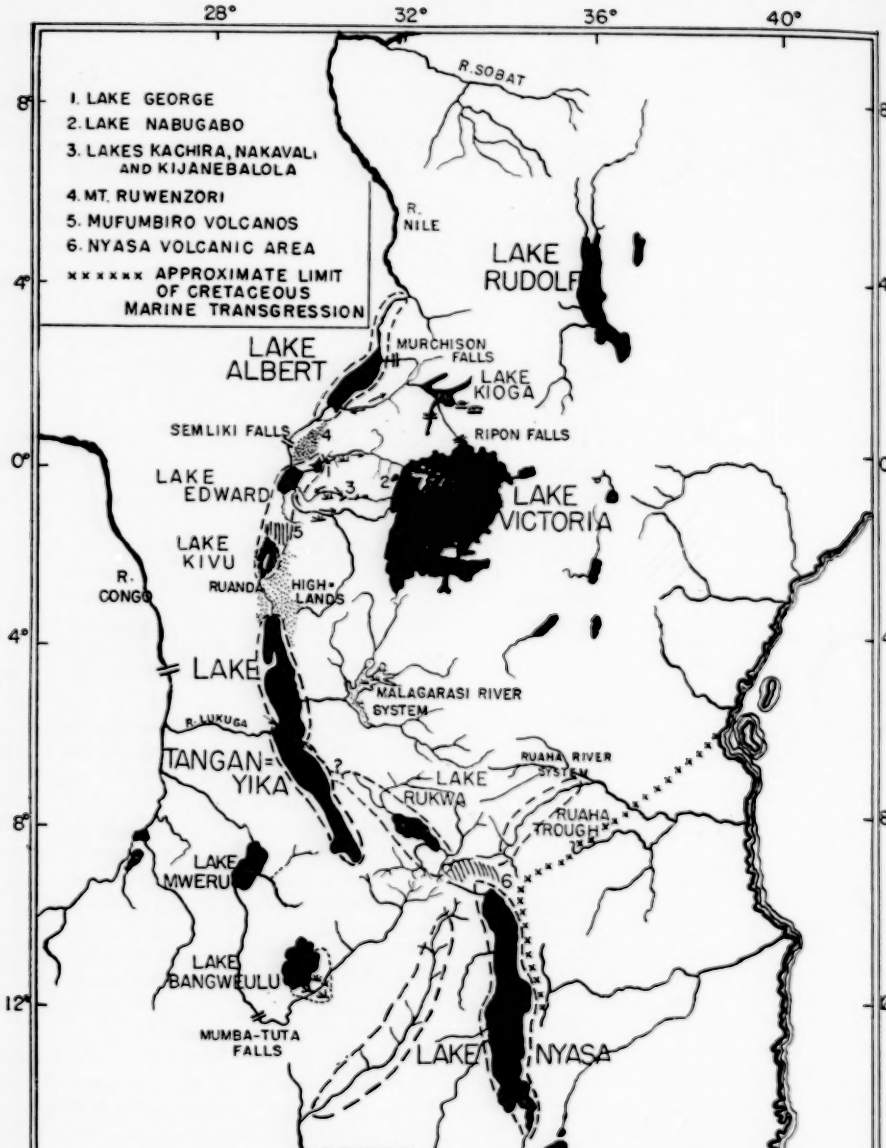

FIG. 6. EAST AFRICAN LAKES AND THEIR HYDROGRAPHIC CONNECTIONS
The major geomorphic features essential to an understanding of the history of the lakes are indicated.

while in the northern half most of it is deeper than 300 m. There are no indications of submerged ridges subdividing the lake basin.

Although these two African lakes are morphometrically similar to Baikal, the dissimilarity of their thermal properties causes a markedly different distribution of life within them. The difference in latitude between Baikal and these two lakes, which lie between 3°S. and 15°S. at elevations of less than 800 m., is the primary cause of the dissimilarity. A brief discussion of the physics and chemistry of Tanganyika and Nyasa must therefore precede a consideration of their biotas. The only satisfactory hydrological study of these lakes on which such a study can be based is that done by Beauchamp in the late 1930's and published in 1939, 1940, and 1946.

The temperature of both Tanganyika and Nyasa is permanently above 4°C. and the deep layers are stagnant, cut off from the freely circulating upper layers, and therefore without oxygen. The waters of Tanganyika below 300 m. are always at 23.1°C. During the summer the upper 60-meter layer reaches a temperature of 25.75°C. At the bottom of this freely circulating layer, or epilimnion, the temperature drops rapidly with increasing depth. Between 60 and 80 m. it drops from 25.75 to 23.75°C. This water level of rapid temperature change with depth in a stratified lake is called the thermocline. The depth of the thermocline varies between 40 and 100 m. in different parts of the lake. A lake is stratified if the buoyance of the warmer upper layers is so great that the wind cannot push this lighter water into the denser, cooler water below, thereby mixing them. The density difference between water at 26°C. and that of water at 23°C. is as great as that between waters of 16°C. and 10°C. Below 80 m. the temperature drops slowly to the minimum, 23.1°C., at 300 m. Tanganyika is stratified for eleven months of the year. The surface waters lose heat during the winter, becoming less buoyant and capable of being submerged by the wind to greater depths. At the time of maximum mixing the temperature drops steadily from 25°C. at the surface to 23.7°C. at a depth of 125 m. From this depth down to 300 m. the temperature slowly decreases to 23.1°C. The surface waters at 25°C. are still sufficiently less dense than the deep waters just above 23°C., so that the wind cannot mix them.

The vertical distribution of dissolved oxygen within the upper 100 meters of water is seasonally variable, but below this depth the water is always devoid of oxygen. During stratification the epilimnion contains 7 p.p.m. O_2—85 per cent saturation. A few meters below the bottom of this circulating layer the water is oxygen-less. This sets a sharp lower limit to the distribution of aerobic organisms during this period. At the time of maximum mixing the oxygen content drops rapidly from 7.5 p.p.m. at the surface to one third of one p.p.m. at 90 m. This rapid diminution in O_2 concentration with increasing depth within the freely circulating waters is due to the mixing of water oxygenated at the surface with the oxygen-less water between 60 and 100 meters. This means that for organisms living in the upper 60 meters less oxygen will be available in the months of mixing than during the period of stratification. For example, the open waters at a depth of 50 m. contain 7 p.p.m. O_2 in the summer and only 4 p.p.m. in the winter. At 70 m., on the other hand, no oxygen is available during stratification, and at the time of maximum mixing the oxygen concentration has only reached 3.5 p.p.m.

The thermal regime of Nyasa is sufficiently different from that of Tanganyika to merit individual treatment. The water below 300 m. is isothermal but one degree cooler than the Tanganyika minimum. The surface waters reach a temperature of 27°C., over one degree warmer than Tanganyika. During this period of stratification the drop in temperature at the bottom of the epiliminion is less abrupt here, but the thermocline is well marked. Between 40 and 65 m. the temperature drops from 26.3°C. to 23.7°C. It drops at an ever decreasing rate below this depth to the minimum at 300 m. At the time of its maximum the freely mixed layer, isothermal at 23.3°C., is 100 m. thick.

The more extensive mixing of the waters of Nyasa is attributed by Beauchamp to the winds playing over the lake, which are not only stronger than those on Tanganyika but also more variable in direction. The latter circumstance is of considerable significance because of the greatly increased turbulent mixing of the upper layer of the hypolimnion induced by the changes in the rate and direction of flow of the water at the bottom of the epilimnion.

This induced turbulent mixing of the water between 60 and 200 m. results in a vertical distribution of oxygen quite different from that in Tanganyika. The epilimnion contains about 6 p.p.m.

O_2 during summer stratification. Below 60 m. the concentration gradually drops to very near zero at 200 m. Water at a depth of 150 m. contains 3.5 p.p.m. O_2 under these conditions. At the maximum mixing the upper 100 m. have over 6.5 p.p.m. of dissolved oxygen, and at 150 m. there are 5.5 p.p.m. Below this depth, however, O_2 concentration drops rapidly to 1 p.p.m. at 200 m. Traces can be found as deep as 275 m. At a depth of 180 m. there are 2 p.p.m. O_2 present in the open waters throughout the year. Thus the depth to which aerobic organisms in Nyasa can descend is much greater than in Tanganyika.

As both Tanganyika and Nyasa are situated on the boundary between subarid and subhumid regions, there is reason to believe that in prehistoric times, as in the past century, the lakes have alternately possessed and lacked outlets, depending upon the water level (Gillman, 1933). Tanganyika is nearer to the subarid region, and it is a bit surprising that the accumulation of solutes in its water is not greater than it is. The salt concentration is 400 p.p.m. (Beauchamp, 1939). There is no evidence that either the total concentration of solutes or the proportion of the ions has had any important effect on the lake's biota, either by the exclusion of any faunal elements or by influencing the process of speciation. Beauchamp's suggestion (1940) that large amounts of potassium and magnesium may have caused the development of some of the species peculiar to the lake is very improbable. The water of Nyasa is more like that of Baikal in its low salt concentration.

The Nyasan Fauna

The dominant elements of the Nyasan fauna are fish and molluscs, according to Moore (1903). Less conspicuous but exceedingly numerous are chironomid larvae whose adults form huge clouds over the surface of the lake at certain times of the year. As these emergences usually occur just after the period of the mixing of oxygenated water to greater depths, it is reasonable to assume that a large part of the population of chironomid larvae lives in relatively deep water (Beauchamp, 1940).

The taxonomy of the gastropod and pelecypod molluscs of Nyasa has long been in a chaotic state, and no modern revision has been made. Pilsbry and Bequaert (1927) have provisionally assigned most of the snails of Nyasa to the genus *Melanoides*, a group widely distributed throughout the tropics of the Old World. It is almost impossible to ascertain the number of species in this flock, although Cunnington (1920) has concluded that there are seven endemic species. The pelecypods are represented by seven endemic unionids and four endemic mutelids (Cunnington), but their generic status is uncertain.

The taxonomy of Nyasan fishes has been extensively studied. Recently Trewavas (1931, 1935) has revised the cichlids, and Worthington (1933) has brought out knowledge of the other families up to date. Ricardo-Bertram, Borley, and Trewavas (1942) introduced slight modifications into the cichlid taxonomy, according to Poll (1946), but their paper was not available to this reviewer. The systematic distribution of the Nyasan fishes is summarized in Tables 4 and 5.

The cichlids have speciated out of all proportion to representatives of other families. There are 174 endemic cichlids in Lake Nyasa, all but five of which are related to *Haplochromis*, a genus also found in other African freshwaters. One hundred and one are placed in this genus; the more divergent species are distributed in 20 endemic genera. Many species of this flock have a characteristic color pattern rarely seen in non-Nyasan species. Regan (1922) stated: "The indications are that the endemic Nyasa cichlids have originated in the lake from about half-a-dozen ancestral forms." All but a single species of *Haplochromis* (*H. callipterus*) are closely related and undoubtedly form a species flock together with several monotypic genera created for highly divergent species whose *Haplochromis* affinities are still evident (Regan, 1922; Trewavas, 1935). The 24 species of *Lethrinops*, all of which feed on bottom-living insect larvae, constitute another species flock. The 23 species which are abundant among the rocks on the rocky stretches of shore, and which Trewavas (1948) has called rockfish, are clearly related to each other, although placed in nine genera (*Pseudotropheus* (11), *Petrotilapia* (1), *Cyathochromis* (1), *Cynotilapia* (1), *Labeotropheus* (*1*), *Christyella* (*1*), *Melanochromis* (5), *Genyochromis* (1), *Labidochromis* (1), forming a species flock). The eight members of *Rhamphochromis* are open-water predators (Trewavas, 1948).

The five endemic Nyasan cichlids not related to *Haplochromis* belong to the non-endemic genus *Tilapia*, but constitute an indisputable species flock, as Trewavas has shown. In her 1948 paper, Trewavas emphasized the inapplicability of Mayr's hypothesis of multiple invasion in explaining the origin of these Nyasan species flocks.

The cyprinid genus *Barbus*, with eight endemic species, is the only large non-cichlid species association, part of which may represent a species flock which has developed within the lake from a single stock. However, the presence of six non-endemic species of *Barbus* in Nyasa makes it necessary to consider the possibility of multiple invasions as an explanation of the endemic as well as the non-endemic species. This is discussed subsequently.

Development of Lake Nyasa and origin of its fauna

Two differences between Lakes Baikal and Nyasa are apparent. First, the paucity of animal groups in Nyasa compared with Baikal is striking. Second, most of the Nyasa populations judged specifically distinct are still sufficiently like their relatives outside the lake to be retained in non-endemic genera. Only among the cichlid fishes are there endemic genera, although about half of the species of fish of other families and all of the gastropods and pelecypods are endemic. This contrasts with the Baikalian fauna, of which only a few endemic species of fish exhibit sufficient relationship to non-Baikalian species to be placed in the same genera.

The explanation of the lack of divergence of the Nyasan fauna from that of the common fauna of African freshwaters is to be sought in the details of development of the lake basin. Most of our knowledge of the geological history of Lake Nyasa is based on the work of Dixie, who has investigated this region over the past twenty years. In his opinion Lake Nyasa had its origin in a small lake in the northern part of the present basin. Here three series of deposits, in part lacustrine, are exposed well above the present lake level. The mammalian fossils of the middle (Chiwando) beds contained mastodon and hippopotamus remains (Hopwood, cited in Dixie, 1927), and on this evidence Dixie (1941) has placed the origin of Lake Nyasa about Middle Pleistocene. As the length of the Pleistocene is estimated at one million years on the basis of radioactive determinations (Zeuner, 1946), the age of Lake Nyasa is of the order of 500,000 years. Similar estimates have assigned 70 million years to the Cenzoic, so that Lake Baikal is of the order of 50 million or more years old, at least ten times as old as Nyasa.

The original, small Lake Nyasa is believed by Dixie to have stood some 750 meters above the present lake level. Through faulting and erosion its level was lowered by stages and it elongated southward. Downthrusting of the southern half of the present basin resulted in the extension of the lake to its present southern limits.

According to the interpretation of Dixie (1939), the Nyasa-Shire trough was a valley as long ago as early Cretaceous, and apparently was part of a drainage system of which the modern Zambesi is the direct descendant. This is in accord with the zoogeographic evidence, for the affinities of the fish in Nyasa are all with the Zambesi and the rivers of East Africa, with no indication of affinity with the Congo Basin.

The six species of molluscs which Connelly was able to find in the fossil material from the Chiwando beds are in no wise remarkable, as they are forms still widely distributed in African freshwaters (Connelly, cited in Dixie, 1927).

The harpacticoid copepod genus *Schizopera*, with a single endemic species in Nyasa, is the only element of this lake's fauna which cannot be ascribed to the African freshwater fauna. This genus occurs in widely scattered coastal brackish water the world over and has been discovered in freshwater situations of both Italy and Sumatra. The *Schizopera* problem also arises in connection with Lake Tanganyika.

Distribution and Speciation in Nyasa

The presence, in a lake as young as Nyasa apparently is, of several large species flocks, one of them the largest found in any lake, indicates relatively rapid cleavage of the original populations. As the evidence in Baikal has demonstrated the probability that intra-lacustrine geographical isolation is responsible for such cleavage, we must examine the possibilities of geographical isolation within Nyasa.

Moore (1903) observed at the end of the last century that the Nyasan fauna, which he considered to be composed of crocodiles, fish, and molluscs, was restricted to a narrow littoral zone running around the lake. This habitable zone is shallow, for Moore was unable to find any organisms living below 35–50 m. The distribution of the fauna, particularly the molluscs, along this narrow strip of shore is unequal, as is clearly brought out in Moore's words:

"Thus the Molluscs in Nyasa live chiefly in the sheltered bays and creeks which communicate with the open body of the lake, each bay forming in itself a colony wherein a number of molluscs live practically

TABLE 4

Synopsis of fish faunas of Lakes Tanganyika, Nyasa, and Victoria

P = Species Present but not Endemic; E = Endemic Species; GE = Endemic Genus; * = Endemic Genus.

FAMILIES	LAKE TANGANYIKA	LAKE NYASA	GENERA IN TANGANYIKA	GENERA IN NYASA	VICTORIA NYANZA
Protopteridae	1P		*Protopterus*		1P
Polypteridae	1P		*Polypterus*		
Clupeidae	2E (2GE)		* *Limnothrissa* * *Stolothrissa*		
Mormyridae	6P	5P, 1E	*Mormyrops*, *Marcusenius* 2, *Gnathonemus* 2, *Mormyrus*	*Marcusenius*, *Gnathonemus* 2, *Mormyrops*, *Petrocephalus*, *Mormyrus*	2P, 4E
Characinidae	5P, 1E	1P	*Hydrocyon*, *Alestes* 3, *Micralestes* 2	*Alestes*	
Citharinidae	1P, 1E		*Citharinus*, * *Distichodus*		1P, 1E
Cyprinidae	7P, 7E	8P, 14E	*Barbus* 6, *Varicorhynchus* 2, *Labeo*, *Barilius* 3, *Engraulicypris* 2	*Barbus* 14, *Varicorhynchus*, *Labeo* 4, *Barilius* 2, *Engraulicypris*	4P, 10E
Bagridae	2P, 8E (2GE)	1E	*Bagrus*, * *Chrysichthys* 5, * *Phyllonemus* 2, *Lophiobagrus*, *Auchenoglanis*	*Bagrus*	1P, 1E
Mochocidae	1P, 4E	1P	*Synodontis* 5	*Synodontis*	2E
Amphiliidae	1P	1P	*Amphilius*	*Amphilius*	
Schilbeidae	1P	1P	*Schilbe*	*Eutropius*	1P
Clariidae	4P, 2E (2GE)	4P, 2E	*Clarias* 3, *Heterobranchus*, * *Dinopterus*, * *Tanganikallobes*	*Clarias* 6	4P, 2E

Malapteruridae	1P	1P	*Malapterurus*	*Malapterurus*	
Cyprinodontidae	1P, 2E (1GE)	1P, 1E	*Aplocheilichthys*, * *Lamprichthys* 2	*Aplocheilichthys*, *Nothobranchius*	2P, 1E
Centropomidae	4E (1GE)		*Lates* 2, * *Luciolates* 2		
Anabantidae	1P	2P	*Ctenopoma*	*Ctenopoma* 2	1P
Mastacembelidae	1P, 6E	1E	*Mastacembelus* 7	*Mastacembelus*	1E
Cichlidae	2P, 89E (34GE)	4P, 174 E (20GE)	See Table 5	See Table 5	5P, 58E, (3GE)
Total No. Families	18	13			12
Total No. Genera	79	44			25
Total No. Endemic Genera	42	20			3
Total No. Species	162	223			103
Total No. Endemic Species	126	196			80

isolated from the other colonies which are distributed around the shore. Storms and floods effect the dispersion of members of these colonies at different times and in this way every colonisable area of the lake becomes filled with molluscs, but in general the individual population of each colonisable area remains cut off and isolated from all the rest. The actual illustrations of these phenomena are often very interesting and instructive. Thus the *Viviparia unicolor*, which is generally found in Nyasa, and frequents more diversely conditioned parts of the lake than any other form, is replaced in Monkey Bay (a small bay near the southern end of the lake) by a type nearly three times as large, and so far as I know, this variety occurs in no other part of the lake." (Moore, 1903, p. 149, parentheses added).

Our present knowledge is still so scant that it is impossible to affirm or to deny the validity of this example of intralacustrine geographic speciation in the molluscs, but we have a little information about the distribution of the fish within Nyasa. Dr. Cuthbert Christy collected fish from various places at the southern and also at the northern end of the lake. Each of the eight endemic species of *Barbus* was taken at both ends of the lake (Worthington, 1933), but some species of *Haplochromis* and of *Pseudotropheus* appear to be localized. Trewavas (1935) has given the known distribution records of the species of *Haplochromis*, based largely upon the Christy collections. Some data are available concerning the distribution of 84 of the 101 species. Of these, 41 have been found at both ends of the lake, 24 are known only from the southern, and 16 only from the northern end. The northern and southern populations of one species of *Haplochromis* found at both ends of the lake differed sufficiently to be considered subspecies by Miss Trewavas. Two species of *Haplochromis* are listed as occurring in all parts of the lake, but there are no records of the distribution of most species along the eastern and western coasts.

TABLE 5

Sizes of endemic genera of fishes of Tanganyika and Nyasa

NO. SPECIES/GENUS	TANGANYIKA			NYASA	
	Non-Cichlids	Cichlids	Names of Cichlid Genera	Cichlids	Names of Cichlid Genera
1	5	20		14	
2	3	4		1	
3		5		2	
4		1	*Trematocara*		
5		1	*Bathybates*	1	*Melanochromis*
6		2	*Telmatochromis*, *Limnochromis*		
7					
8				1	*Rhamphochromis*
9					
10					
11				1	*Pseudotropheus*
19		1	*Lamprologus*		
24				1	*Lethrinops*
	11	83	Total no. of Species in Endemic Genera	70	
ENDEMIC CICHLIDS OF NON-ENDEMIC GENERA					
Total no. of endemic species of Cichlids		3	*Haplochromis*	101	*Haplochromis*
		3	(3 monotypic genera)	5	*Tilapia*
		89		176	

Two species of *Pseudotropheus* have been taken at both ends of the lake. The northern and southern populations of another species (*P. tropheops*) were designated as being subspecifically different. Three other species occurred only in collections at a single end of the lake. One was southern and two were northern. No data on the intralacustrine distribution of *Lethrinops* species are available. It is of considerable importance that the scant knowledge we possess about the distribution of the members of Nyasan flocks indicates that there are intralacustrine geographical subspecies and allopatric species.

Any consideration at the present time of the possibility of geographical speciation within Lake Nyasa must be based upon the cichlid species flocks, since only these have received adequate taxonomic treatment. If intralacustrine geographical isolation is here involved, as the distributional evidence would indicate, there must have been, during the development of the lake, barriers subdividing and isolating once continuous populations for periods sufficiently long to allow genetic divergence. We must examine the modern lake for evidence of intralacustrine geographical barriers effective today. Should any be found, it is possible that their counterparts existed in the past.

Moore (1903) observed that the molluscs and fish, the groups with species flocks, are confined to the shallow littoral zone of sheltered bays and inlets, extending to depths of less than 50 m. Oxygen lack might be the limiting factor. As noted above, during 1937 the oxygen content of the open waters from the surface down to 50 m. was always greater than 6 p.p.m., while below this depth the oxygen content dropped steadily, particularly during the summer (Beauchamp, 1940). Since the water in contact with the mud undoubtedly has a lower oxygen concentration than does the open water, the oxygen tension in the microzone occupied by benthic animals may be too low, below a depth of 50 meters, to support aerobic life. The chironomids, which probably can live at greater depths, are exceptional. The headlands and wave-pounded beaches between the bays appear to be largely uninhabited. Trewavas (1948), however, stated that the rocky shores are inhabited by at least the *Pseudotropheus* group of 9 cichlid genera (with 23 species). Their specialized dentition is presumably employed in removing algae from rock surfaces, although Trewavas did not state this explicitly. These algae-covered rocks probably have a shallow depth range also. The alternation of these different habitats along the shallow habitable strip of lake bottom isolates portions of any population which is restricted to either habitat.

There is at least one section of the shore of Nyasa which, according to Rhoades' map, is so precipitous that the bottom down to below 50 m. not only must be rocky but exceedingly narrow as well. Along the northern half of the west shore, between Nkata Bay and Mrowi to the north, the bottom drops precipitously to over 350 m. for a distance of about 25 km. Similar stretches of steep, but not quite so precipitous shore occur on the northeast coast, to the north and south of Kaiser Bay. It is likely that these portions of the bottom act as barriers to the spread of bay-inhabiting benthic organisms, while the bays are barriers for the rock fishes. This constitutes the most evident type of geographical isolating mechanism effective in Nyasa today.

Moore stated with regard to the mollusca in Nyasa that "great extents of its shore and deep bottom are un-inhabited" (1898, p. 168). The uninhabited shores to which he refers are probably not the precipitous stretch just discussed, but smaller segments of the lake's shoreline. If his observations on the distinctness of the population of *Viviparia unicolor* in Monkey Bay are correct, these smaller segments of uninhabited shore, as well as the rocky shores, are acting to isolate subpopulations of "bay molluscs."

These geographical features would act as barriers only for organisms which are closely tied to a specific type of substratum. The snails which are apparently represented by species flocks are clearly benthic. The habitat requirements of the fish are so diverse that relatively little is known of them. Worthington (1933) constructed a food chain for the non-cichlids, but for the more interesting and more numerous cichlids it has not been possible to do much more than to state, as Worthington did (1933, p. 291), that the cichlids include "phytophagous, insectivorous, molluscivorous, and piscivorous forms." Trewavas (1948) has contributed the only detailed information on food habits. The previously mentioned rockfish are closely associated with a certain substratum, and all species of *Lethrinops* are benthic feeders. The little-studied feeding habits of the hundred species of *Haplochromis* must be very diverse, if one may judge from those of some of the highly divergent

monotypic genera. *Chilotilapia* feeds on molluscs. *Aristochromis* is the terminal member of a series of predacious species of *Haplochromis*. Possibly these, and certainly the eight members of *Rhamphochromis* which are open water predators, are not associated with the substratum by their food habits, although they may be by their reproductive behavior. Miss Trewavas has informed me in a personal communication that when native fishermen wish to catch certain species of cichlid plankton feeders they go to various offshore rocks. This may be taken at least as an indication that populations of Nyasan cichlids which are no longer bottom feeders may still be anchored to small portions of the lake.

The most extraordinary trophic specialization is to be seen in the two species of *Corematodus* (*Haplochromis* except for their file-like dentition) which feed solely upon the small scales on the tails of other cichlids. While *C. toeniatus* has the dark oblique band from nape to caudal fin which is common to many species of this *Haplochromis* species flock, *C. shiranus* bears vertical black bars extending from back to venter. This pattern is strikingly similar to that of females and non-breeding males of *Tilapia squamipinnis*, with which *C. shiranus* associates. *T. squamipinnis* is a plankton feeder which occurs in shoals, and an occasional *Corematodus shiranus* is taken in hauls with numerous *Tilapia*. It is tempting to suppose that *Corematodus* is able to swim unnoticed among the *Tilapia* and feed by nibbling at the small scales at the base of the *Tilapia's* tails. The cichlid scales in the *Corematodus* stomachs unfortunately cannot be specifically identified. No other adequate hypothesis has been advanced to account for this striking resemblance of two unrelated cichlids (Trewavas, 1947b).

Even the fragmentary information on the ecological and intralacustrine distribution of the Nyasan cichlids allows us to see that one species, *Pseudotropeus tropheops*, which is closely associated with rocky bottom, is represented by geographical subspecies. This betokens the presence of isolating mechanisms effective now or in the immediate past. On the basis of our knowledge of speciation in Lake Baikal, the assumption appears justified that geographical factors, whose existence has been pointed out, are involved as the primary isolating mechanism.

However, the cichlid stocks not only in Nyasa but also in Tanganyika and in Victoria Nyanza have speciated to an unparalleled degree, and there can be little doubt that biological factors are acting here to reinforce the initial isolation controlled by intralacustrine geography. Kosswig (1947) has suggested that specialized breeding behavior may be important in restricting genic interchange. Thus any genetic divergence in a population isolated for only a relatively short time might, particularly if the color pattern were altered, lead to inbreeding and more or less complete reproductive isolation even when the geographical barriers are no longer effective. The only flock of Nyasan cichlids which has been studied with reference to this question is that of four species of *Tilapia* so closely similar that they were considered a single species up to 1939. Only one of these has been given a Latin name (*T. karongae*). Trewavas (1947a) referred to the others by their local names, Chambo, Saka, and Lidole. Details of the biology of Chambo and Lidole were given in the 1947 note. Both species are phytoplankton feeders and differences in feeding habits are difficult to detect, although some divergence may exist, as Chambo feeds closer to shore than does Lidole. There are slight differences in dentition, development of pharyngeal bones, and size of mouth. However, the two species are readily distinguishable during their period of breeding. The mature Chambo males are pale blue, while the Lidole males are black. Females and non-breeding males are silver-grey with nearly vertical black bars. Despite the morphological similarity of the females of the two species, their behavior in caring for eggs and young is divergent. Chambo carries the eggs and shelters the young until they have reached a total length of 15 mm., at which time she deposits them in a reed-bed. Lidole continues to shelter her young until they have reached a total length of 40 mm., dispensing with the reed-beds. The mating areas of these two species, whose feeding areas overlap, are separate. Miss R. Lowe, Trewavas' associate, is pursuing field studies of the other two species. Graham (1929) has described the differences in structure and breeding behavior in the two closely similar species of *Tilapia* in Victoria Nyanza.

It may be concluded that at the present time the fauna of Nyasa is subdivided into more or less isolated regions and that the rate of genic flow between them must be slow and may even be completely blocked at one or more places. There is no reason to believe that this same kind of distribution has not been characteristic of Nyasa in the past. The frequently abrupt alterations of

the geographical pattern in such a tectonic trough would permit the commingling of long separated neighboring populations and the separation of once continuous populations. The importance of biological factors in the rapid speciation of the cichlida is evident.

The Tanganyika Fauna

The Tanganyika fauna is intermediate between those of Nyasa and Baikal in the diversity of stocks present and the number of species by which many are represented. In the character of its affinities, too, the Tanganyika fauna falls between Baikal and Nyasa. A few of the Tanganyikan stocks belong to groups with wide distributions throughout fresh and brackish waters, but most stocks are characteristic of African freshwaters. A single species has its only known relative living in the East Indian Ocean.

The bulk of the Tanganyikan fauna has been derived from African freshwater stocks which have subsequently undergone more cleavage and divergence than have the Nyasan representatives. This divergence is evident from the many groups which are represented by endemic genera. The molluscs are most remarkable, as 25 of the 44 genera are endemic. As only two of these endemic genera appear to be relicts, the others must have arisen through intralacustrine specialization. The Cichlidae, with about half as many species as in Nyasa, have 34 endemic genera against the 20 in Nyasa. Five of the other families of fish have endemic genera in Tanganyika. Endemic genera are also to be found among the prawns, and possibly the ostracods. Two remarkable water-bugs have been made the types of the genera *Paskia* and *Idiocoris*. These two genera of heterotrephids constitute the subfamily Idiocorinae, which is peculiar to Lake Tanganyika (Esaki and China, 1927).

Many Tanganyikan genera, both endemic and non-endemic, are represented by groups of closely related species. It is our chief concern to ascertain whether these associations arose through intralacustrine cleavage, i.e., are species flocks, and if so, what geographical factors were responsible for isolating the populations within the lake. The principal species associations are found among the fish, molluscs, prawns, ostracods, and copepods. The taxonomy of these faunal groups is reasonably complete. Pilsbry and Bequaert (1927) have revised the molluscs on the basis of all known material, which is still scant. Poll has recently published (1946) a revision of the fishes of Tanganyika. The prawns have been studied by Calman (1906), the copepods by G. O. Sars (1909) and Gurney (1928), and the ostracods by G. O. Sars (1910).

The copepods are well represented in Lake Tanganyika, with 29 species described from two series of collections. Two species (*Ergasilioides*) are parasitic and will not be considered further. One free-living species is a calanoid. There are 18 cyclopoids and 9 harpacticoids. *Tropodiaptomus simplex* (Sars) is not only planktonic, as are most calanoids, but is the principal zooplankter of the lake. Harpacticoids on the other hand are bottom-dwellers, and cyclopoids are known which belong either to the open water or the bottom community. As we might expect, the species flocks, of which there appear to be three, are confined to the bottom-dwelling forms. The eight known members of the harpacticoid genus *Schizopera* (Diosaccidae) of Tanganyika form an indisputable species flock. When Sars described the species, he stated that in his opinion the flock developed in the lake from a single ancestral stock. An equal number of species are known outside of Lake Tanganyika, chiefly in brackish water, although two occur in fresh. Gurney reported that there is at least one other species of *Schizopera* in Tanganyika which he could recognize from its peculiar cast skins but could not describe. Kiefer's classification (1929) of the Cyclopoida, as amended by his subsequent elevation of the subgenera to generic rank, will be utilized in the treatment of this group. All of the Tanganyikan species belong to two subfamilies of the Cyclopidae. Eucyclopinae is represented by four genera, *Paracyclops*, *Ectocyclops*, *Tropocyclops*, and *Eucyclops*, the first two having one and two Tanganyika species, respectively. *Tropocyclops* has but a single species widely disseminated in tropical freshwaters. Seven species are attributed to the fourth genus *Eucyclops*, and four of these are endemic. The seven species of the other subfamily, Cyclopinae, are closely related, being referred to the genus *Microcyclops*. Six of these have not been found elsewhere. Of these two species associations Gurney said: "we find a remarkable wealth of closely-allied forms of the genera *Eucyclops* and *Microcyclops*, which seems to indicate a kind of explosive evolution from a few primary inhabitants" (1928, p. 318, l. 10–13). Although little is known of the ecology of these copepods, the indications are that these two large groups are bottom-dwellers. It is almost certain, therefore,

that one species flock has evolved among the copepods of the Tanganyikan bottom community, and it is probable that there are two others. The reservations which must be borne in mind while considering these two cyclopoid species associations are discussed below.

TABLE 6

Prosobranchiate molluscs of Lake Tanganyika

GENERA	SPECIES PER GENUS	
A. *Tanganyicia* group		
Tanganyicia Crosse	4	
Stanleya Bourguignat	1	
Baizea (*Baizea*) Brgnt	1	
Baizea (*Coulboisia*) Brgnt	3	
Baizea (*Giraudia*) Brgnt	2	
Reymondia Brgnt	3	
Bridouxi Brgnt	1 (?)	
B. *Spekia* group		
Spekia Brgnt	1	
C. *Tiphobia* group		
Tiphobia Smith	1	
Bathanalia Moore	1	
D. *Limnotrochus* group		
Limnotrochus Smith	1	
Chytra Moore	1	
E. *Paramelania* group		
Paramelania (*Paramelania*) Smith	3	
Paramelania (*Bythoceras*) Moore	2	
F. *Lavigeria* group		
Lavigeria Brgnt	8	*
Joubertia Brgnt	3	
Randabelia Brgnt	2	
Hirthia Ancey	2	
Edgaria Brgnt	11	
Lechaptoisia Ancey	1 (?)	
G. *Syrnolopsis* group		
Syrnolopsis Smith	3	
Anceya (*Anceya*) Brgnt	4	
Anceya (*Burtonilla*) Smith	1	
Martelia Dautzenberg	2	

* Should be merged into *Lavigeria* (P. and B., 1927).

The remarkable profusion of 12 endemic species of prawns in Tanganyika is all the more striking by contrast with those two other mighty African lakes, Nyasa and Victoria, each of which has but a single non-endemic species. Calman considered it likely that 11 of the Tanganyika species form one species flock. The odd species belongs to the widely distributed tropical genus *Palaemon*. The 11 members of the species flock have been put into the genera *Limnocardina*, *Caridella*, and *Atyella* having seven, two, and two species, respectively, of the family Atyidae, characteristic of tropical, freshwaters of both the Old and New Worlds.

There are two genera of ostracods in Lake Tanganyika, with large species associations which are almost certainly species flocks. *Paracypria* is represented by 11 endemic species and a twelfth which has been taken also in Lake Albert. This genus may belong to the brackish water element, because the type species was described from the same brackish lagoon on the Chatham Islands as *Schizopera*. Eight species of endemic ostracods from Lake Tanganyika have been assigned to *Cypridopsis*, although they are rather different from other members of the genus, typical representatives of which are found in Nyasa and Victoria Nyanza, one species in each, and these Tanganyikan species should probably be considered to constitute an endemic genus.

Lake Tanganyika not only has many endemic species of molluscs belonging to genera found in Lake Nyasa and elsewhere in Africa, but also has a large number of endemic genera. There are two large endemic genera of pelecypods. *Grandidieria* with 13 species belongs to the Unionidae, and *Pseudopatha* with 5 species pertains to the family Mutelidae. The most remarkable molluscs, however, are the 64 species of prosobranchiate snails, whose relation to other African snails is obscure. Many have come to resemble marine snails in their adaptation to similar habitats and are often referred to as "thalassoid." Table 6 lists the genera to which these thalassoid species are best assigned. Representatives of each group of closely-related genera are shown in Fig. 7. Pilsbry and Bequaert (1927) have expressed the opinion that 17 genera (groups A–F of Table 6) are melaniids. The other three genera (group G) are known only from empty shells and can be tentatively considered a peculiar family, the Syrnolopsidae, possibly related to the Amnicolidae. Possibly all 17 melaniid genera represent one highly diversified species flock.

Although 18 families of fish are represented in Tanganyika, over half of the total number of species belongs to a single family, the Cichlidae

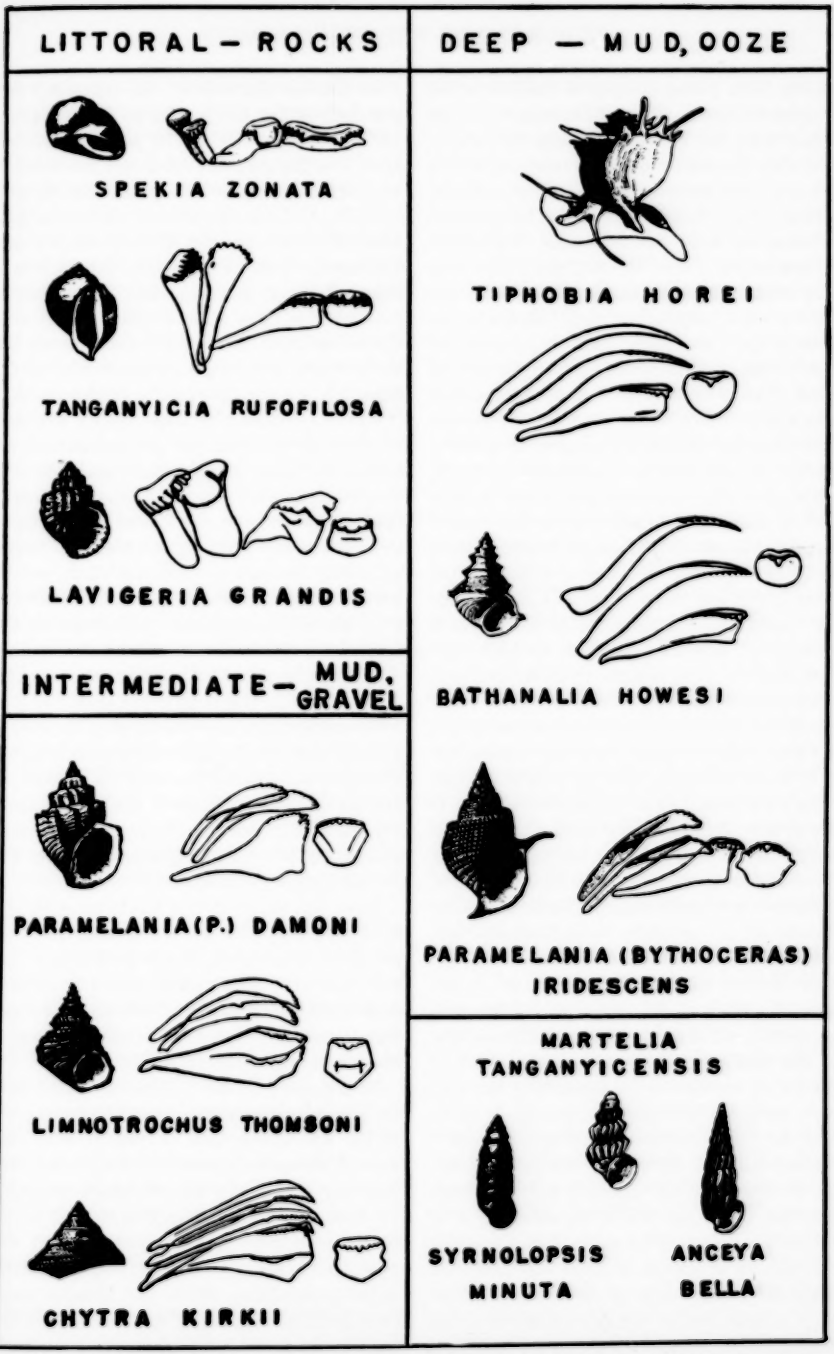

FIG. 7. SHELLS AND RADULAE OF REPRESENTATIVE SPECIES OF TANGANYIKA PROSOBRANCHIATE ("THALASSOID") SNAILS

Spekia zonata, width 13 mm.; *Tanganyicia rufofilosa*, length 11 mm.; *Lavigeria grandis*, length ?; *Tiphobia horei*, length 45 mm.; *Bathanalia howesi*, length (?), ca. 20 mm.; *Paramelania* (*P.*) *damoni*, length 32 mm.; *Paramelania* (*B.*) *iridescens*, length 110 mm.; *Limnotrochus thomsoni*, length 20 mm.; *Chytra kirkii*, length 10 mm.; *Syrnolopsis minuta*, length 5 mm.; *Martelia tanganyicensis*, length 2.3 mm.; *Anceya bella*, length 10 mm. (The three figures in lower right-hand corner from Pilsbry and Bequaert, 1927; others from Moore, 1903.)

(Table 4). This preponderance of cichlids is not as great as in Nyasa, where it amounts to 80 per cent. Beginning our investigation with this family, we find that there are no genera which approach in size the *Haplochromis* group of Lake Nyasa. *Lamprologus* has 19 species in Lake Tanganyika, and *Telmatochromis*, *Limnochromis*, *Bathybates*, and *Trematocara* have six, six, five, and four species, respectively (Table 5). Poll (1946) has considered that *Lamprologus* and *Telmatochromis* arose from the same stock. This would give the largest cichlid species flock in Tanganyika 25 members. The 23 monotypic endemic genera may contain species which belong to these flocks, but most of them are so highly divergent that determinations of affinity are extremely difficult. *Haplochromis*, which has undergone a tremendous amount of cleavage in Lake Nyasa, has only 5 species in the Tanganyika drainage area, and these are more characteristic of the rivers than of the lake itself. All five endemic species inhabit the rivers, whereas only three of these species have been taken in the lake. *Tilapia*, another non-endemic cichlid genus, is represented by two non-endemic species, probably recent invaders.

Among the other families there are five species associations, each of which may have arisen entirely or in part through cleavage within the lake of a single ancestral stock. Although there are 19 species of the cyprinid *Barbus* in the Tanganyika drainage basin, only six occur in the lake, and only one is restricted to the lake. Four of these six are endemic and may constitute a species flock. The Mastacembelidae, a family of eel-shaped fish, are represented by six endemic and one non-endemic species. (Poll, 1946, listed an eighth species, *M. christyi*, Worthington and Ricardo 1936, as doubtful). The catfish genus *Chrysichthys* of the Bagridae has five endemic species. Another catfish genus, *Synodontis* (Mochocidae), has four endemic and one non-endemic species in Lake Tanganyika. The African centropomids, large predaceous fish, all belong to the genus *Lates*, except for two of the four endemic species in Lake Tanganyika, which are sufficiently different to be placed in the closely allied genus *Luciolates*. The four Tanganyikan species of *Lates* and *Luciolates* probably have evolved in the lake from a single stock. A comparison of the fish faunas of Lakes Tanganyika and Nyasa, employing Tables 4 and 5 and the information of the preceding paragraphs, indicates some of the evolutionary complexities that can be obscured in the statement that 87 per cent of the 223 species of fish in Nyasa are endemic as opposed to 78 per cent of the 162 species in Tanganyika. All of the thirteen families of Lake Nyasa are also present in Lake Tanganyika, and the comparison will be restricted to these thirteen. The cichlids will receive separate treatment. The twelve other families in Lake Nyasa have 45 species, while Lake Tanganyika totals 61 for these same families. Thirty-seven of the 61 in Lake Tanganyika are endemic (61%), while there are 20 endemics in Nyasa (44%). Nineteen of the 37 species endemic to Lake Tanganyika belong to large species associations, of which three (see above) are undoubtedly species flocks. In Lake Nyasa *Mastacembleus* and the Bagridae are each represented by single endemic species, and there is only one non-endemic, *Synodontis*. *Barbus*, with eight endemics, forms the only large Nyasan species association, and this is a doubtful species flock. *Lates* and *Luciolates* comprise the only large species association which does not belong to one of the twelve common families. The endemics of both lakes which are not members of species flocks (the large ones named and possibly a few species pairs in addition) must each represent a population which has become sufficiently modified since its introduction into the lake to receive specific distinction. None of the Nyasan endemics are sufficiently divergent to be placed in endemic genera, but five endemic genera have been created for six Tanganyikan species.

From this comparison of the 12 non-cichlid families common to both lakes, it is clear that not only are there more species flocks in Tanganyika, but also that the Tanganyikan stocks have changed more during their stay in the lake, as is apparent from the greater percentage of endemic species and the presence of endemic genera.

Turning now to the Cichlidae, we find that according to the latest tally (Trewavas, 1948), Nyasa has 178 species, or nearly twice the 91 which have been named from Tanganyika. Ninety-eight per cent of the cichlid species of each lake are endemic. Furthermore, it is evident that most of these endemic species arose through the repeated cleavage of a relatively small number of initial populations. All of the Nyasan endemics have probably developed from between 6 and 10 stocks, one of which has given rise to at least 106 species, by far the largest species flock known in any lake. Estimation of the number of original

cichlid stocks in Tanganyika is more difficult. The Tanganyika cichlids exhibit a greater degree of divergence from each other and from populations outside of the lake than do those of Lake Nyasa, making it difficult to determine the relationship between genera. Of the 34 endemic genera, 5 are large, with between 4 and 19 species each, and as a maximum estimate each may be considered a separate species flock. It is highly improbable that the 29 other endemic genera are each derived from a single stock. It is much more likely that these genera, each with between one and three species, represent highly divergent members of a much smaller number of species flocks. It can be assumed that the numbers of initial cichlid populations stocking the two lakes were rouchly the same. If this assumption is correct, there must have been about twice as much cleavage of these initial populations in Lake Nyasa as in Lake Tanganyika. However, the Tanganyikan species exhibit a greater morphological differentiation, as there are 34 endemic genera for 91 species against 20 endemic genera for the 171 species of Lake Nyasa. In this aspect the cichlids resemble the other families. The picture is consistent with the geological evidence, to be considered later, that Lake Tanganyika is older than Lake Nyasa. However, the greater amount of cleavage which has unquestionably occurred in the cichlid stocks of Nyasa must indicate unusually favorable conditions for intralacustrine geographical speciation of that particular element of the fauna.

Worthington (1937), on the basis of his extensive studies of the fish faunas of the African lakes, has suggested that the large predators *Lates* and *Hydrocyon* "have been important factors in controlling the number and variety of Cichlids" (op. cit., p. 310). (The basis for his suggestion will be discussed in connection with Victoria Nyanza.) This is consistent with the findings in Lakes Tanganyika and Nyasa, as both genera are absent from Nyasa, where the amount of speciation has been greater. However, in view of the possible importance of other unstudied factors, it seems advisable to withhold judgment on the relative importance of predation.

Geological history of Tanganyika and origin of its fauna

A summary of the geological and biological evidence relating to the development of the lake and the origin of its fauna, with some mention of the hypotheses which have been elaborated thereupon, is necessary here, since these hypotheses are divergent and often conflicting. This presentation of the geological development of Lake Tanganyika and the surrounding region is based primarily upon material in Willis' monograph of 1936, the latest available summary of East African geology.

Although Lake Tanganyika had its beginning in the latest series of earth movements to affect the topography of East Central Africa, we must extend our investigation farther into the past. Upon doing so it is evident that this plateau region has been above the seas for the greater part of geological time. Highly metamorphosed Pre-Cambrian rock is the foundation rock of the region. The only sedimentary beds, not only in this region but also in the great Congo Basin to the west, are freshwater beds. Over the greater part of what is now British East Africa two peneplains are recognized. The earlier has been dated as Jurassic. From late Palaeozoic to early Jurassic times vast deposits were laid down in the Congo Basin, undoubtedly derived in part from the erosion of the lands to the east. During the Jurassic this peneplained area was uplifted from 300 to 900 meters, and stream erosion had again reduced the topography to a peneplain by the Miocene. Once again the land was elevated, this time by 90 to 150 meters, and before this cycle of erosion, which Willis has named the Malagarasi, had more than achieved maturity in the less resistant rock, the region was convulsed by movements begun in the Pliocene and still in progress.

During the Malagarasi cycle most of the drainage of the area now occupied by Lake Tanganyika was toward the west. One of Lake Tanganyika's major affluents, the Malagarasi River, which drains a large area immediately to the east of the lake, represents one of these old westward flowing rivers which was beheaded by the formation of the lake. There is evidence that at the southern end of Tanganyika a large river, the Chisyera, flowed to the east before the lake was formed. Cameron Bay, the distinct lobe on the west shore at the southern end, is the drowned valley of this antecedent river. The land now covered by the lake was therefore near, if not on, the divide between eastern and western watersheds.

Those crustal disturbances of the Pliocene which gave rise to Lake Tanganyika were vertical displacements that resulted in the formation of a

series of troughs which have been called the Eastern and Western Rift Valleys. The Western Rift Valley is shown on the map (Fig. 6). This so-called rift valley is not now, nor was it ever, a continuous trough from one end to the other, as Suess suggested in 1891 before the region had been adequately explored. Rather it is, as Willis was at pains to emphasize, a series of structures aligned along an arc, and the result of both upthrusts and downthrusts. In this western arc there are three downwarps, the Albert, the Edward-George-Kivu and the Tanganyika troughs, named in order from north to south. These downwarped areas are indicated within the interrupted lines on the map. It will be noted that there are three separate highlands situated along this arc, but all are not upwarps. Only Mt. Ruwenzori, the Mountains of the Moon, is an upwarp, an integral part of the crustal deformation which produced the two downwarps immediately to the north and south. The Ruanda Highland, standing farther to the south between the Edward-Kivu and Tanganyika downwarps, antedates the formation of these depressions, being a large mass of resistant rock exposed during the preceding two cycles of stream erosion. The Mufumbiro volcanos arose within the Edward-Kivu trough, which they now subdivide, at a much later date. This last event will be discussed subsequently, as it had important effects on the development of Lake Tanganyika.

The Tanganyika trough, in which our interest centers, is in actuality two troughs en echelon. The Kungwe Peninsula stands at the southern end of the northern trough, and the submerged ridge trending northwest from this peninsula to the headland on the west shore is a strip of the ancient land marking the separation between the two downwarps. Willis established (1936, p. 215) that any areas of the bottom of Lake Tanganyika now standing about 570 meters below the lake's surface are at about the general level before the vertical displacements began. The most recent bathymetric survey has determined that the top of the submerged ridge has an average depth of about 500 meters (data of Copart). This agrees admirably with the deduction that this remnant of the old land surface has been left as a ridge by the sinking of the adjacent troughs. There is no evidence to indicate whether these troughs formed simultaneously, or whether an interval of sufficient duration elapsed between the two events to be of consequence in the evolution of the lake's fauna.

As the troughs began to form, they trapped the water of the rivers which had once flowed across that area. The head waters of westward flowing rivers such as the Malagarasi drained into the troughs, leaving the lower courses of their valleys without their previous supply. Possibly the headwaters of the Chisyera River, which had cut the valley of Cameron Bay, had also been interrupted in their eastward course, swelling the lake beginning in the troughs. Subsequently, due to unequal elevation of the land, its course was reversed so that the modern Chisyera, of meagre proportions, drains westward into Lake Mwero. The deepening troughs retained their water, so that for a large part of its history, undoubtedly the greater part, Tanganyika was at the center of a basin of internal drainage. The inhabitants of the rivers, and the swamps and lakes if there were any, were thus isolated. The majority of the peculiar species of Tanganyika developed from the inhabitants of these freshwaters during that long period of isolation.

It is necessary to emphasize at this point that there is no geological evidence to substantiate the belief that Lake Tanganyika ever had an outlet into the Nile. One of the prime objectives of the Second Tanganyika Expedition, led by J. E. S. Moore, was to ascertain the soundness of Suess' conjecture of such a connection between Lake Tanganyika and the Nile. The expedition found unequivocal evidence that such a northern extension of the lake never existed (Moore, 1903, p. 83). All subsequent investigators have substantiated this. Willis has summarized our knowledge of the Ruanda Highland which constitutes the barrier to the extension of Lake Tanganyika to the north:

"North of Lake Tanganyika rises the highland of Ruanda, a dome-like elevation, some 300 miles in diameter. Its base in the general level of the plateau may be taken at the contour of 5000 feet (1500 meters). It approaches Lake Tanganyika, Lake Victoria, and Lake George, and extends west beyond Lake Kivu on to the Congo watershed. The area is roughly 120,000 square miles (300,000 sq. km.) and the top of the dome, somewhat north of the central district, reaches 6,500 feet (2000 meters).

"Thus doming up some 500 meters above the rest of the plateau, we might expect this highland to be bounded by faults, but none are known to define it. It is deeply and maturely eroded, in contrast to the typical plateau surface, and yet carries in its summits remnants of an older peneplain, which is correlated with the Jurassic peneplain of the southeastern coast

of Tanganyika. The physiographic observations by Combe have demonstrated that it was already in Miocene times and earlier a relatively elevated region, into which valleys penetrated headward from the Miocene peneplain. It was thus a headwater area in that period and then as now the highest upland in East Africa" (1936, p. 36, lines 14–29).

It is rather surprising, therefore, to find several recent statements to the effect that Lake Tanganyika had, or might have, once drained into the Nile. Robert, in the third edition (1946) of his *Le Congo Physique*, has stated:

"L'histoire du lac Tanganyika paraît être très compliquée et est loin d'être suffisamment connue. On peut cependant, dès à présent, supposer que les phénomènes y relatifs se sont succédé de la manière suivante. Dans l'ancienne bande en dépression, qui était l'amorce du graben actuel, s'étendait un lac qui avait un écoulement vers le Nord et qui alimentait la vallée du Kivu, ainsi que les lacs Edouard et Albert et enfin le Nil. Le barrage formé par les venues éruptives, au Sud de la zone où est actuellement localisé le lac Kivu, ainsi que les effondrements rélativement récents qui se sont produits localement dans la zone du Tanganyika, ont modifié cet ancien état de choses et fait du Tanganyika un lac sans écoulement" (p. 200, lines 31–41).

This statement, for which no authority is given, must be considered erroneous. Poll (1946), when writing of the fish fauna of Lake Tanganyika, used the second edition of Robert's book as a source for the geological history of the lake and was misled into a belief that the peculiar fish fauna of the lake was of Nilotic origin. However, as Worthington (1936) has pointed out, the origin of the fish fauna of Lake Tanganyika was in the piscine stocks of the African rivers of Pliocene times. A large part was undoubtedly derived from westward flowing rivers, accounting for many of the similarities of the endemic species to stocks now living in the Congo basin. The cyprinid *Labeo weeksii* is found within the Tanganyika drainage basin only in the headwaters of the tributaries of the Malagarasi River System, although it is widely distributed throughout the Congo basin. Although Poll (1946) found this distribution unexpected, it is to be expected if the Malagarasi once drained directly into the Congo, as there is reason to believe it did. *Barbus eutaenia*, similarly restricted to the upper parts of the Malagarasi System within the Tanganyika drainage area, occurs in the Katanga region of the Congo watershed, Angola, Transvaal, and Lake Nyasa. This species, too, probably inhabited the Malagarasi before Lake Tanganyika was formed.

Fuchs (1936) discovered in the Kaiso beds (early Pleistocene) bordering Lakes Albert and Edward fossil molluscs similar to some stocks now living in Lake Tanganyika. He placed a viviparid snail in the genus *Neothauma*, which at present occurs only in Tanganyika. However, the form which lived in Lakes Albert and Edward is specifically distinct (*N. dubium*) from the extant *N. tanganyicense*. Two species of fossil unionids resemble *Grandidieria* of Lake Tanganyika, but in the absence of the soft parts necessary for proper generic differentiation Fuchs has wisely retained the older and more inclusive name *Unio*. On the basis of these palaeontological discoveries, Worthington and Ricardo concluded:

"In the first place, it is postulated that at some early period Lake Tanganyika was much more extensive than now, particularly towards the north, and was probably in communication with the lakes and rivers in the northern part of the Rift valley, including the Nile. Evidence for a northward extension of Lake Tanganyika is brought forward by Fuchs (in press), who shows that fossil molluscs from the Kaiso beds, of the Middle Pleistocene period, near Lake Edward, are closely related to the present forms living in Lake Tanganyika, and differ markedly from any known to exist in Lake Edward today." (1936, p. 1070, lines 32–39).

As such a northward extension is excluded geologically, the explanation of the presence of these fossil molluscs is undoubtedly that suggested by Fuchs himself, namely, that these genera represent a molluscan fauna which enjoyed a wide distribution over that region of central East Africa during Wayland's first Pluvial period. During the excessive aridity of the first Pleistocene interpluvial period (cf. Wayland, 1934) these forms became extinct as all of the permanent habitable waters of the region disappeared. Fuchs' discovery of the remains of crocodiles and *Lates*, the Nile perch, in the Kaiso beds of Lake Edward, where neither of these forms live at present, provided further evidence of the desiccation of Lake Edward with the extinction of its archaic fauna. *Neothauma* and *Grandidieria* were able to survive only in Lake Tanganyika, which never dried up because of its great depth. Subsequently Fuchs (1939) studied the fossil molluscs of the Gaza Beds in the Lake Rudolf basin. The recent molluscan fauna of Rudolf, like that of Lakes Albert and Edward, is essentially nilotic. Three species characteristic

of the Kaiso Beds of Uganda occurred together in all the Gaza samples. These are *Viviparus unicolor*, *Cleopatra ferruginea*, and *Unio* (*Grandidieria*) *abruptus*. None of these is found in any later deposits. The Gaza Beds were presumably laid down during the first pluvial, like the Kaiso. Connelly (cited in Dixie, 1927) found the first species, i.e., the snails, in the Chiwando (middle Pleistocene) beds of Lake Nyasa, which is not surprising in the light of their present wide distribution in Africa. More important is the absence of *Neothauma* and *Grandidieria*.

Lake Tanganyika remained isolated within its basin of internal drainage for a period whose duration cannot be accurately estimated. The lake had its inception sometime during the Pliocene, which lasted about 13 million years according to the best evidence available (Zeuner, 1946). Even if this event occurred in late Pliocene, the lake would have been at least one to two million years old at the end of this epoch. The events which led to the termination of this phase of the lake's history took place during the middle of the late Pleistocene, an epoch which lasted about one million years. A minimum estimate of the duration of the isolation of Lake Tanganyika would therefore be one and one-half million years, while a reasonable maximum would be six million.

The events leading to Lake Tanganyika's acquisition of an outlet began many miles to the north. The eruption of a chain of volcanos across the Edward-Kivu downwarp blocked the northward escape of water from the northern slopes of the Ruanda Highlands. These impounded waters formed Lake Kivu in the drowned head-end of the valley which had previously drained into Lake Edward. Lake Kivu grew until it topped the lowest point in the highlands surrounding it. This low point was on the south rim, so that the overflowing waters drained into Lake Tanganyika. The inflow to Tanganyika now exceeded evaporation and its level rose until it reached a low point in its rim. This low point appears to have been an old westward running valley of the Malagarasi cycle of erosion, which had been beheaded by the sinking of the Tanganyika troughs. Once again water flowed westward in this valley down into the Congo Basin as Lake Tanganyika gained an outlet, the Lukuga River, and lost that isolation during which its fauna had evolved along peculiar lines. Moore, leading the Second Tanganyika Expedition, was the first to read this story from the geography north of Tanganyika.

The formation of the Mufumbiro chain of nine volcanos, which had such far-reaching effects upon the drainage pattern of Central Africa, was not a single event but appears to have extended over the greater part of the Pleistocene. The volcanos occur in three groups of three. The eastern and central groups comprise craters no longer active and eroded to such an extent that their formation has been referred to the early Pleistocene (Willis, 1936, based on the studies of Coombe). The volcanos of the western group are now active and probably are of later origin than the other two groups, although more precise dating has not been possible. This western group is so situated that it appears to be the one responsible for the damming of the river of the Kivu valley. As Lake Kivu, therefore, had its origin during the middle or late Pleistocene, its final consequence, the formation of the Lukuga River, occurred after the lapse of an unestimated interval.

These recent hydrographic changes involving Tanganyika are reflected by the distribution of some of the non-endemic species of Tanganyika fish. Species which have been introduced into Tanganyika from Kivu constitute but a minor fraction and are easily differentiated. However, the acquisition of a recent connection with the Congo Basin, via the Lukuga River, with the attendant possibilities of faunal interchange, renders difficult the interpretation of the origin and affinities of many endemic species.

There are only two species of fish found in the Tanganyika basin as well as in Lakes Kivu and Edward (Poll, 1946). These two species are closely related, *Barbus serrifer* Blgr. and *B. pellegrini* Poll. Both fish are associated with the affluents within the Tanganyika basin; indeed, *B. pellegrini* is never found in the lake, living only in the upper reaches of the Malagarasi River. *B. serrifer* inhabits all the other tributaries and has only been taken in the lake itself close to the mouths of these affluents. In the Kivu and Edward basins also, these fish exhibit a preference for the tributaries rather than the lakes themselves. It is not surprising then that, when the headwaters of a large tributary of Lake Edward were cut off from the lower reaches of the system, only the rheophil species of the basin would be present to stock the new Lake Kivu. As few fish (two, from Poll's data) have been able to ascend the torrential

Ruzizi from Tanganyika to supplement these stocks, the poverty of the Kivu fauna is understandable. *B. serrifer* has been found in two rivers of the Congo Basin, the Uele and the Ituri (Poll, 1946), whose headwaters are in the highlands to the west of Lakes Albert and Edward. Its restriction to these two rivers of the Congo System makes it likely that *B. serrifer* gained entry into these Congo tributaries by stream capture involving their headwaters and those of tributaries of Lake Edward.

There have been three possibilities for interchange between Lake Tanganyika and the rest of the Congo System by which the manifest similarities between their fish faunas might have arisen:

1. Species inhabiting the Congo System during Pliocene times might have been trapped in the newly-formed basin of internal drainage centering about Lake Tanganyika.

2. Species might have migrated into the lake through the recently formed Lukuga connection.

3. Species might have spread from Lake Tanganyika into the Congo System through the Lukuga.

Any stocks introduced into Lake Tanganyika at its formation (1), would in all probability have evolved sufficiently during the period of isolation in adaptation to lacustrine conditions to be no longer conspecific with the descendants of these stocks in the Congo Basin. The affinities of some of the endemic species are not clear, but others show an evident relation to the stocks still living in the Congo Basin. An example is the predaceous centropomid *Lates*. *Lates nilotica* is widespread throughout the Nile and Congo Systems. This species does not occur in Tanganyika, although four obviously related species do. Two of these are sufficiently like *L. nilotica* to be retained in the same genus, but the other two have been separated into the endemid genus *Luciolates*. If *Labeo weeksii* and *Barbus eutaenia* (cf. p. 147), which inhabit the headwater streams of the Tanganyika drainage basin, colonized these headwaters before the lake formed, as is likely, then these populations have been isolated from the nonspecific ones in the headwaters of the Congo basin proper for as long a time as those other species from which the peculiar lacustrine forms have developed. That they have not diverged noticeably can only be attributed to the constancy of their environment.

Although some of the non-endemic species of Tanganyika fish may have survived the period of isolation without specific divergences, many, particularly those which also live in rivers, have undoubtedly invaded the lake since the recent formation of the Lukuga River connection (2). It seems likely, for example, that the only two non-endemic cichlids of Tanganyika, *Tilapia nilotica* and *Tilapia melanopleura*, are recent invaders. Both have very large areas of distribution and are as much at home in rivers as in lakes. Worthington (1936) believes that the Kakoma Rapids of the Lukuga may constitute a barrier to the spread of many species from the Congo Basin into Tanganyika. In all, 33 of the 48 non-endemic fish of Tanganyika occur now in the Congo Basin.

One clear case of the recent spread of a fish from Lake Tanganyika to the rest of the Congo System (3), according to Poll, 1946, is that of the cichlid genus *Lamprologus*. *Lamprologus* is represented in Tanganyika by 19 species. Poll (1939) has listed only three other species from the rest of the Congo System, two without description, although he had expressed the opinion in 1933 that there were probably only two valid species. The numerical dominance in Tanganyika, together with the presence there of species of *Telmatochromis* which Poll has considered very like the stock from which *Lamprologus* differentiated, led him to the conclusion that the latter genus has evolved in the lake. One of the 19 present-day Tanganyika species, *L. stappersi* Poll, can maintain itself in rivers, and from some such stock the two or three species in the lower parts of the system have apparently developed.

The last hydrographic connection to be considered is that between Tanganyika and Rukwa, a small lake lying in its own downwarp (see map) about 190 km. (80 mi.) east of the southern end of the larger lake. The connection, if it ever existed, was undoubtedly through a valley or depression running between the two troughs, called the Karema Gap. However, within this valley there is a rise to about the highest lake level discovered in the Rukwa trough, viz., some 200 meters above the surface of the present lake. Many geologists in the past and as late as 1936 (de la Vallée Poussin) have considered the geological evidence favorable to the hypothesis of a connection; but Teale (1930, quoted in Willis, 1936) believed the field evidence to be inconclusive. On the other hand, Stockley (1939) was firmly convinced that there never was any direct hy-

drographic connection between the two lakes. The most convincing support for the hypothesis of a direct connection comes from the discovery of numerous fossil snail shells in the now dry lake beds north of the present Lake Rukwa. These shells pertain to the thalassoid genus *Edgaria* of Tanganyika, (Cox, 1939). If Stockley were correct, it is exceedingly difficult to imagine any way in which *Edgaria*, which is restricted to rocky, sheltered shores in Lake Tanganyika, could have gained entrance into Rukwa. On the other hand, if there had been a connection, it is odd that only one genus of thalassoid snails should be found in Rukwa, and not more.

The present molluscan fauna bears no relation to that of the fossil beds. This is taken as evidence that Lake Rukwa, which is never more than 5–6 meters deep at present and which dries up in part during the rainless season, must have dried up completely subsequent to the deposition of the extensive fossiliferous beds. Possibly this occurred during the first major interpluvial, coinciding with the desiccation of the shallow lakes to the north, i.e., Lakes Edward, Albert, Victoria, and Rudolf.

Ricardo (1939) reported that three species of fish are common to Tanganyika and Rukwa. Two of these are cyprinids, *Barilius moorei* and *Engraulicypris congicus rukwaensis*, and the third is the catfish *Clarias hilgendorpi*. Poll (1946) was doubtful of the validity of this latter species, and it cannot be used in the present discussion. *Barilius moorei*, as noted above, also occurs in Kivu, and *Engraulicypris* occurs elsewhere in the Congo System. Ricardo, considering that the two cyprinids are typical of the open waters of Tanganyika, believed that their presence in Rukwa supports the hypothesis that an open water connection existed between the two lakes at some time in the past. Any fish which had entered Rukwa from Tanganyika through the supposed connection would not have been able to survive the period of desiccation which the molluscan evidence requires. However, *Barilius moorei* has been taken in streams and brooks tributary to Lake Tanganyika (Poll, 1946), and has been able to reach Lake Kivu by ascending the Ruzizi. *Engraulicypris congicus* is equally at home in rivers. Since *E. congicus* has not been reported from Lake Bangweulu, it is unlikely that it entered Lake Rukwa from the Chambezi (Ricardo-Bertram, 1943). Introduction of these fish into Rukwa through capture of the headwaters of tributaries of Lake Tanganyika by those of Lake Rukwa, or through swamps draining into both watersheds, is most probable.

The geological history of central Africa aids in elucidating the origin only of some of the piscine and a few molluscan stocks. The origins of other stocks remain obscure, for many undoubtedly go back to the time of the lake's formation. The thalassoid snails presumably are derived from fluviatile ancestors which were present at the lake's genesis, but these descendants have so far given no clue to the relationships of their ancestors. Other groups of molluscs may have invaded at later periods (Pilsbry and Bequaert, 1927). The prawns clearly belong to a family which has long inhabited tropical rivers and ponds. Their presence in Lake Tanganyika, like that of the fish and molluscs, is comprehensible even though detailed information be wanting.

There are several groups in Tanganyika whose close relatives have such remarkable distributions outside of the lake that their very presence in the lake is perplexing. The harpacticoid copepod genus *Schizopera* occurs in coastal brackish waters around the world (Egypt, Chatham Islands, Hawaii, Haiti, Caspian Sea). Freshwater species have been found in Toba Lake, Sumatra, and in the subterranean waters of southern Italy. The gymnolaematous bryozoan *Victorella* occurs not only in the coastal brackish waters of Europe and Asia but in some of the basins in the interior of Asia as well. Furthermore, a marine species was discovered by Harmer (1915) in the East Indian Ocean. The marine affinity of the other of the two Tanganyikan gymnolaematous bryozoans, *Arachnoidea raylankesteri*, is even more evident, because the only other species which has been assigned to this genus was found in the Straits of Makassar in the East Indian Ocean.

As in the consideration of the origin of the Baikalian fauna, several interpretations of these patterns of distribution are possible. Tanganyika might once have been an arm of the sea, or it might have been connected with a basin which once had been a part of the sea, and subsequently have been freshened. According to either of these possibilities Tanganyika is considered to have had a special link with the sea, and the fauna so derived would have no close relation to the faunas of the other freshwaters, unless they had spread from Tanganyika. Opposed to this is the interpretation of this special element in Tanganyika as the relict

of an archaic fauna which has been supplanted in most freshwaters.

Early knowledge of the peculiarities of the Tanganyikan fauna, in particular the "thalassoid" appearance of snail shells collected by Speke, and Böhm's discovery of the trachyline medusa *Limnocnida tanganicae*, suggested a marine origin for this lake. Moore espoused this hypothesis and in a series of papers presented what appeared to be biological evidence that Lake Tanganyika arose as an arm of the Jurassic sea. As knowledge of the faunas of Tanganyika and the other lakes and rivers of Central Africa increased, Moore's biological evidence lost its cogency and the accumulating geological information made it quite clear that the sea had never reached the site of Lake Tanganyika. Cunnington (1920) ably mustered all of the pertinent information to prove that the hypothesis as presented by Moore was untenable.

However, the discovery of the marine species of the bryozoan *Arachnoidea*, made subsequent to Moore's latest presentation of his hypothesis, and the gradual accumulation of information about the distribution of such forms as *Schizopera* and *Victorella* bolsters the appearance of affinity between Tanganyika and the sea. In attempting an explanation of this apparent affinity it is necessary to give serious consideration to the possibility that Tanganyika gained some or all of this special element of its fauna from a modified marine basin. This would parallel Vereščagin's hypothesis of the origin of the "marine" element of Lake Baikal. The hypothetical basin could not have been to the west of the present lake, as no marine deposits are known in the Congo Basin. Evidence already considered proves that the connection could not have been to the north, i.e., to the Nile Basin. The nearest marine transgression to the lake was on the east, indicated by the Jurassic, Cretaceous, and early Tertiary marine strata of the eastern part of Tanganyika Territory. Although the westernmost position of the sea coast is uncertain, due to the erosion of the marine beds, it may possibly have reached the edge of the central plateau during the Cretaceous, as indicated on the map. (Information from Willis' account (1936) of the geological history of Tanganyika Territory). Therefore, any such basin must have been east of the site of Lake Tanganyika near the western limit of transgression. Crustal movements were common at the time of these transgressions and there is a possibility that a small basin might have become landlocked. The Ruaha River system which drains that area of the plateau immediately to the east of the Tanganyika drainage basin has maintained itself since pre-Cretaceous times. The modified marine fauna would then have been carried as far west as Tanganyika via ponds and lakes formed along its course by crustal deformations. At present part of the Ruaha trough (see map) is drained into the Ruaha system, while the western end drains into Lake Rukwa. Lacustrine deposits cover the bottom of the Ruaha trough and suggest that a possible route was through these ponds or lakes to Rukwa and then to Tanganyika.

There is no evidence to indicate which of the three marine transgressions was involved, although that of the Cretaceous extended nearest to Tanganyika. If the postulated basin was originally a part of the Cretaceous sea, then the time interval before the formation of Lake Tanganyika is reasonably adequate.

The known facts of the distribution of close relatives of the special element of the Tanganyikan fauna lend themselves less readily to their interpretation as the relics of an archaic fauna of continental waters than do those for the similar element in Lake Baikal.

Distribution and speciation within Lake Tanganyika

With this synopsis of the animals which appear to have speciated within the lake and the origin of their ancestral populations now behind us, we can proceed to an examination of their distribution for evidence of intralacustrine geographical speciation. The available information concerning spatial distribution of the members of these flocks is poorer than for Lake Nyasa. The collections of prawns and copepods have been too limited to provide any concept of their distribution. Although Poll (1946) has compiled much information on the distribution of the fish species within Lake Tanganyika, this cannot substitute for a field investigation of distribution. It is most regrettable that Christy's field notes, giving the localities of his large collection of Tanganyika fishes, were lost after his death (Worthington and Ricardo, 1936). Unless they are found there is little hope of learning more about the distribution of the endemic species of fish in the near future.

The largest collections of molluscs have been made by the expeditions led by Moore, 1895–1899,

TABLE 7

e distribution of thalassoid snails in Lake Tanganyika

(Based on table in Dartevelle and Schwetz, 1948)

SPECIES	NO. SPECIES (Stappers)	HORIZONTAL DISTRIBUTION (WEST COAST)	VERTICAL DISTRIBUTION (Moore and Cunnington)	VERTICAL DISTRIBUTION (Stappers)
Rocky Littoral				
Spekia zonata	689	N–S	0–30 M.	0–70 (chiefly at shallow depths)
Tanganyicia rufofilosa	3005	N–S		0–70
Tanganyicia soluta	2	N		
Stanleya neritinoides	1001	N, C		3–33 (chiefly at 35 M.)
Giraudia tanganyicensis	15	S		20 (1 species)
Giraudia horei	184	C, S	16.5	7–55 (chiefly at 20 M.)
Giraudia minor	137	C, S		0–35
Lavigeria grandis	298	C, S	0–30	0–70
Hirthia littorina	2	S		
Hirthia globosa	6	C, S		
Edgaria arenarum	18	S		76 (1 species)
Edgaria crassilabris	95	C, S		15–76
Edgaria egregia	2	S		
Edgaria formosa	3	S		
Edgaria giraudi	2031	N–S		0–45 (few species)
Edgaria lechaptoisi	3	S		
Edgaria nassa	2029	N–S		0–100
Edgaria n. livingstoniana	295	C, S		0–70
Edgaria milne-edwardi	2	S		
Edgaria paucicostata	1015	N–S		0–110
Edgaria singularis	106	C, S		0–45 (2 species)
Intermediate				
Paramelania (P.) damoni	109	N–S	41–65	3–100 (chiefly below 20)
Paramelania (P.) crassigranulata	13	N–S		1–35 (few species)
Limnotrochus thomsoni	173	N–S	16–125	0–70
Chytra kirkii	193	N–S	33	9–150
Deep				
Tiphobia horei	42	N–S	76–300	76–100
Bathanalia howesi	1	S	126–300	76
Paramelania (B.) iridescens	69	N–S		0–125
Syrnolopsis m. minuta	539	C, S		8–35
Syrnolopsis m. carinata	23	C, S		0–100
Syrnolopsis l. lacustris	166	C, S		8.5–20
Syrnolopsis l. molirensis	29	S		3–70
Syrnolopsis l. pluricarinata	25	S		8.5–20
Syrnolopsis l. lilacina	70	Extreme S		0–90
Syrnolopsis gracilis	19	N–S		35–90 (few species)
Anceya giraudi	960	C, S		5–130
Anceya admirabilis	99	S		76–90
Anceya bella	17	C, S		35 (2 species)
Anceya rufocincta	29	S		76 (2 species)

Cunnington, 1904, and Stappers, 1910–1912. Stappers' collection, the most extensive, was not reported until 1948 (Dartevelle and Schwetz, 1948). Although Pilsbry and Bequaert had only a part of the Stappers' material at their disposal in 1927, their system has proven adequate in classifying the bulk of the collection (Table 6). There has never been a systematic endeavor to study the intralacustrine distribution of the molluscs. Only scant knowledge is to be gained by an analysis of the records of the various collections. Stappers' collection, the most useful, yields less pertinent information than might be hoped, because this expedition explored only the west coast. Furthermore, the localities are recorded by Dartevelle and Schwetz only as north, central, or south. Although they concluded that there is no evidence of geographical distribution within the lake, their data (Table 7) support a different interpretation.

Before proceeding with the analysis of the horizontal distribution it is necessary to consider the vertical distribution and ecological preference of the various snails. Stappers' collection is not very helpful in these considerations because of two sorts of omissions from the field records. No indication is given as to whether a specimen was alive or merely a shell when collected. The limits of the vertical distribution may therefore be in considerable error. The second omission is that of any record of the substratum on which a specimen was taken. All the ecological information which was available in 1927 has been analysed and summarized by Pilsbry and Bequaert. This is accepted without alteration by Dartevelle and Schwetz (1948).

The broad aspects of the ecology of the Tanganyika molluscs can be sketched. The molluscs of non-endemic genera abound in the bays and swamps around the lake, just as the Nyasan species of the same genera do. The endemic bivalves, *Grandidieria* and *Pseudospatha*, are now restricted to depths of less than 25–50 m. according to Pilsbry and Bequaert (1927), although Moore in 1898 recorded *Grandidieria burtoni* from much greater depths. (The significance of depth records at different times is discussed in detail below in connection with the thalassoid snails.) The prosobranchiate snails of Tanganyika live in habitats apparently unexploited by any Nyasan snails, although the same habitats surely exist in the latter lake, too. The habitats are of three types, rocks on the surf-pounded stretches of shore, mud and gravel bottom at intermediate depths, and mud bottom at the greatest habitable depths. In Fig. 7 the taxonomic groups occupying each habitat are shown, together with their radulae.

The large genus *Edgaria* is exceptional. Its members live on rocks sheltered from strong wave action. The habitats of syrnolopsids are unknown. Yonge has recently (1938) called attention to the differences in the radular structure in the three ecological groups. The stout-toothed radulae of *Spekia*, *Tanganyicia*, and *Lavigeria* are apparently used to scrape algae from rocks. Moore (1899) found that the radular sac of *Tanganyicia rufofilosa* is very small relative to the size of the snail, and made the further observation that on dissection "the mouth, oesophagus, stomach, and rectum were crammed with sharp rock fragments, about the size of a pin's head; and it is a curious fact that these animals should thus exhibit a propensity to fill themselves with stones, while at the same time the radula, or normal rasping apparatus, is almost entirely lost" (op. cit., p. 157). The radulae of *Tiphobia* and *Bathanalia* have long marginal teeth much like those of *Aporrhais*, which is known to pick up detritus of vegetable origin from the mud. Moore stressed the resemblance of the radula of *Chytra* to that of *Capulus* which, as Yonge has stated, "is now known to act merely as a conveyor into the oesophagus of mucus-laden masses collected by the enlarged ctenidium" (Yonge, 1938, p. 465). The possession of a crystalline style by all of these prosobranchiate snails characterizes herbivorous molluscs, as indeed the majority of other freshwater prosobranchiates have proved to be (Yonge, 1938).

By comparison with Lake Baikal the littoral habitats are likely to be geographically discontinuous, while the deep one is almost certainly less discontinuous, if not continuous. The alteration of bays and headlands is an alternation of at least two types of littoral habitats. The bays of Lake Tanganyika are largely populated by species of non-endemic genera, closely resembling those of Lake Nyasa in this respect. These bays isolate the headlands where rocks exposed to and sheltered from wave action provide different habitats.

In addition to the geographical pattern there are considerable [line 1] variations in the productivity of different parts [line 2] of the lake. Beauchamp (1939) found that the surface layers of the open waters of Tanganyika were unproductive, probably due to their low nitrate content. As a result, the

greatest development of the biota occurs where rivers with a nutrient salt content higher than that of the surface lake water empty into shallow parts of the lake. Here littoral vegetation flourishes and the rocks are covered with algae. The shallow ends of the lake are very productive, as are these local regions mentioned above, but elsewhere the biota is sparse.

The available data on the horizontal distribution of the thalassoid snails indicate that species living in littoral habitats are more localized in that distribution than are those living at greater depths (Tables 7 and 8). Only one-third of the 21 littoral species taken by Stappers were not restricted to portions of the west coast. All four species living at intermediate depths occur in all the basins. Two of the three species inhabiting the deep zone have a similarly wide distribution. *Bathanalia howesi*, however, is exceptional, having been taken only in the southern basin. This localization is probably real even though the species has been rarely taken. This relationship between horizontal and vertical distribution, although based upon scant information, is consistent with the findings in Lake Baikal.

TABLE 8

Summary of distributions of thalassoid snails in Lake Tanganyika

RANGE OF DISTRIBUTION	SYRNOLOPSIDS	MELANIIDS			TOTAL
		ROCKY-LITTORAL	INTERMEDIATE	DEEP	
N–S	1	5	4	2	12
N, C	—	1	—	—	1
N	—	1	—	—	1
C	—	—	—	—	0
C, S	5	7	—	—	12
S	5	7	—	1	13

Another aspect of the horizontal distribution which is apparent from Table 8 is worthy of further mention. Although the three divisions of Dartevelle and Schwetz appear to be to roughly equivalent lengths of coastline, the southern division has 13 species and subspecies restricted to it, the northern has one, and the central has none. Furthermore, twelve of the fourteen forms taken in the northern division occur in the other divisions as well, while two-thirds of all the forms have never been taken at the northern end of the lake. The significance of these regional differences is not apparent.

The ranges in vertical distribution which Moore and Cunnington reported from collections made between 1895–1904 fall within those recorded by Stappers for 1910–1912, with the exception of three species (Table 7). *Limmotrochus thomsoni*, *Tiphobia horei*, and *Bathanalia howesi* were found by Stappers in much shallower water than the previous collectors had found them in. Since the last-named species was taken but once, this finding is of less significance than those pertaining to the other two species, which were well represented in the Stappers collection. This surprising difference in the range of vertical distribution of these snails becomes astonishing when supplemented by the observation of Beauchamp that *Tiphobia horei* was living at the surface of Lake Tanganyika in 1937, and extended down as far as the thermocline, i.e., 60 to 80 m.

And now, since there is no evidence to the contrary, it is assumed that these snails require oxygen and that the lower limit of their distribution will be the depth at which the oxygen concentration in the water in contact with the bottom is nil. In 1937 the open waters, in the summer, contained oxygen down to 60 m. depth during the period of stratification. Beauchamp (1939) reported that at the time of his hydrological observations *Tiphobia horei* was abundant just above the thermocline and could even be found at the surface. At a depth of 80 m. the superficial layer of mud changes from an oxidized to a reduced state (Beauchamp, 1946), and judging from the work of Mortimer (1941), the oxygen content at the mud surface at this depth is probably between 0.5 and 0.1 mg./l. Certainly molluscs cannot live at oxygen tensions lower than this.

The inescapable conclusion from these records is that the depth to which Tanganyika waters have been oxygenated has varied within the last century. To mix oxygen to a depth of 300 m., as apparently occurred in 1895, the epilimnion either must have extended to that depth, or have been somewhat deeper than it is today, and must have had oxygenated water turbulently mixed through the thermocline to a depth of at least 300 m. In Lake Nyasa turbulence in the upper part of the hypolimnion carries oxygen to a depth of 200 m. during summer stratification.

The vertical extent of bottom available for the deep-water species has a considerable effect upon the relations between these and the second ecological group of molluscs, which might be called

the "bay" group. Moore reported in 1898 that the bay group occurred down as far as 50–80 m., while the deep-water forms were living well below this depth. Their areas of distribution overlapped little. In 1937 Beauchamp found *Tiphobia horei*, which Moore had characterized as a deep-water form, living at the surface and down to depths of about 60 m. Its present vertical range is that which the species of the bay group occupied fifty years ago. The effect which this intrusion has had upon the two groups is not known.

It is of great biological importance to know how deep the waters of Tanganyika have been mixed in recent geological times. If the mixing extended to 300 meters fifty years ago, how deep was it mixed two centuries ago? Since prolonged stagnation should lead to gradual settling of heavy isotopes, it ought to be possible, by making a study of the isotopic composition of the hydrogen and oxygen of a vertical series of water samples, to ascertain the maximum depth to which mixing has extended.

The influence of one other geographical feature on intralacustrine speciation remains for discussion. This is the submerged ridge, a continuation of the Kungwe Peninsula which separates the two large basins of Lake Tanganyika. Since the top of the ridge is about 500 m. below the present surface, it can be of no importance as a barrier at the present time, because the biota does not extend that deep. It seems unlikely that at the present lake level the biota ever extended as deep as 500 m. However, at more remote times, during the dry periods of the African Pleistocene, the lake level may well have been low enough for the ridge to be effective in isolating part of the fauna into northern and southern portions. This would have had a profound effect upon intralacustrine speciation, as we have seen a similar ridge may have done in Lake Baikal. It will be recalled in this connection that two-thirds of the species of thalassoid snails are restricted to the southern and central parts of the west coast of Lake Tanganyika.

Multiple invasions

Although we have seen that intralacustrine speciation of a cleavage type has probably been responsible for the formation of species of prawns, three groups of copepods, the majority of the molluscs of Lake Tanganyika, and many groups of fish in both Tanganyika and Nyasa, it is necessary to consider the possible role of multiple invasions in the formation of other types of species associations. Although it is not possible to accept Mayr's suggestion (1942) of multiple invasions as the origin of species flocks, (a conclusion also reached by Trewavas, 1948, for Nyasan cichlids) at least one of the mechanisms of multiple invasion which he proposed has almost certainly been responsible for the presence within a lake of several species of a given genus. The distinction between this latter type of species association and a species flock is that the members of a species flock of a lake are all more closely related to one another than to any population existing outside of the lake.

A tabulation (Table 9) of all non-cichlid associations in Lakes Tanganyika and Nyasa of two or more species of fish containing at least one species widely distributed outside of the lake elucidates a difference in the composition of the associations of the two lakes.

The composition of the Tanganyikan associations is such that the factors involved in their formation can be assigned with fair probability. In the large groups *Barbus*, *Synodontis*, and *Mastacembelus* it is highly probable that the endemics arose through intralacustrine cleavage of stocks introduced into the lake early in its history. The one or two non-endemic species in each genus have undoubtedly been introduced at a relatively recent date. On the other hand, associations composed entirely of non-endemic species, such as those of *Clarias* and *Marcusenius*, can only be the result of multiple invasions. In the four genera with a single endemic and one or two non-endemic species, multiple invasions are almost certainly responsible. The populations considered endemic are those which have been modified during the course of their inhabitation of Lake Tanganyika. Probably they were introduced earlier than the non-endemic species.

Only two Nyasan associations are undoubtedly attributable to multiple invasions alone. These are *Ctenopoma* and *Gnathonemus*. [N.B. Worthington (1933), in assigning the specimens from Lakes Nyasa and Bangweulu to Boulenger's species *C. ctenotis* indicated the probability that *C. ctenotis* may be but synonymous with *C. nanum*, a Congo species. Poll (1946) has questioned the distinction of *C. ctenotis* Boulenger from *C. muriei*, which occurs in Lakes Tanganyika, Victoria, Edward, and the Nile.] Determinations of the relative importance of the two factors are more difficult for the other three associations. In *Clarias* with four

TABLE 9

Modes of formation of the piscine species associations in Lakes Tanganyika and Nyasa

Tanganyika

		NON-ENDEMIC SPECIES WITH DISTRIBUTION OUTSIDE LAKE	
MULTIPLE INVASIONS	*Clarias* 3P	*C. mossambicus*	East Africa to Zambesi; Lakes Nyasa, Victoria, Kivu; Congo
		C. liocephalus	Congo basin
		C. theodorae	Congo (Katanga), Zambesi, Lakes Nyasa and Bangweulu, Rhodesia
	Marcusenius 2P	*M. nigricans*	Lake Victoria
		M. discorhynchus	Congo (Katanga), Zambesi, Lake Nyasa
	Alestes 2P, 1E	*A. imberi*	Congo basin, Rv. Rovuma to Limpolo, Lake Nyasa
		A. macrophthalmus	Gabon and Congo basin
	Barilius 2P, 1E	*B. salmolucius*	Congo basin
		B. moorii	Lakes Kivu and Rukwa
	Varicorhynchus 1P, 1E	*V. ruandae*	Ruanda
	Engraulicypris 1P, 1E	*E. congicus*	Congo basin, Subspecies in Lake Rukwa
MULTIPLE INVASIONS PLUS INTRALACUSTRINE CLEAVAGE	*Barbus* 2P, 4E	*B. aphantogramma*	East Africa and Lake Kivu
		B. serrifer	Lakes Edward and Kivu
	Synodontis 1P, 4E	*S. melanostictus*	Congo basin, Zambesi
	Mastacembelus 1P, 6E	*M. taeniatus*	Katanga (Congo) ?

Nyasa

MULTIPLE INVASIONS	*Ctenopoma* 2P	*C. multispinus*	Zambesi, Lake Mweru, Bechuanaland
		C. ctenolis	? See note in text
	Gnathonemus 1P, 1E	*G. macrolepidotus*	Zambesi
MULTIPLE INVASIONS (PLUS INTRALACUSTRINE CLEAVAGE?)	*Clarias* 4P, 2E	*C. mossambicus*	East Africa to Zambesi, Lakes Tanganyika and Victoria, Congo
		C. mellandi	Lake Bangweulu
		C. carsonii	Uganda
		C. theodorae	Zambesi, Congo (Katanga), Lakes Tanganyika and Bangweulu, Rhodesia
	Labeo 2P, 2E	*L. altilevis*	Zambesi
		L. cylindricus	East Africa to Zambesi, Lake Tanganyika
	Barbus 6P, 8E	*B. trimaculatus*	Zambesi, Transvaal, Zululand
		B. paludinosus	East and South Africa (including Zambesi)
		B. eutaenia	Zambesi, Angola, Transvaal
		B. banguelensis	Lake Bangweulu, Kafubo River (Congo)
		B. innocens	Lake Rukwa, Wami and Mkata Rvs. (Tanganyika Terr.)
		B. rogersi	Upper Zambesi, Angola

non-endemic and two endemic species, and in *Labeo* with two endemics and two non-endemics, it is probable that the endemics of each genus are the result of early double invasions. However, the possibility of intralacustrine cleavage cannot be excluded. *Barbus* presents further difficulties. The six non-endemic species are certainly the result of multiple invasions. How many of the eight

endemics are also? This question can only be answered by an authority. From Worthington's (1933) treatment of this genus it appears that four endemic species (*B. rhoadesii*, *B. eurystomus*, *B. johnstonii*, and *B. globiceps*) are closely related, and therefore it may be considered possible that they arose with the lake. The other three endemic species (the fourth having been considered questionable by Worthington) do not appear to form a group with the genus. Presumably they represent three relatively old invasions.

This total of ten invasions by species of *Barbus* is not as improbable as it first appears, because of the exceedingly large number of species of *Barbus* in the rivers of East and South Africa. *Barbus*, indeed, dominates the fish fauna of this region (Nichols, 1928). Within the Tanganyika drainage basin there are 13 species of *Barbus* restricted to the rivers. Six are endemic. All have presumably invaded this drainage basin. Two occur otherwise only in East African rivers and must have entered the Tanganyika basin from the east. One (*B. pellegrini*) came from Lake Kivu. The other non-endemic species have wider distributions, including the Congo system, and probably entered through the Lukuga. The distribution of the non-endemic Nyasan *Barbus* furnishes some notion of the paths over which the lake may have been invaded. Four have wide distributions, including the Zambezi. Presumably they entered from some part of this system, not necessarily up the Shire, which is blocked by the Murchison Rapids. *B. innocens* has been found outside Lake Nyasa in Lake Rukwa and in the Wami and Mkata Rivers in Tanganyika Territory. Perhaps it entered the Nyasa basin from the northeast. *B. banguelensis* is restricted to Lake Nyasa, Lake Bangweulu, and the Kafubo River (Katanga region of Congo). This distribution can be interpreted either as an invasion of Nyasa from the west or from Nyasa into the rivers to the west of the Nyasa basin.

The differences in the roles which multiple invasions have played in the development of the piscine species associations of Lakes Tanganyika and Nyasa are related to their positions with respect to the rich Nile-West African and poorer East and South African freshwater fish faunas (Nichols, 1928). Lake Tanganyika has recently received contributions from the Nile-West African fauna through the Lukuga and, to a much smaller extent, from the north through Lake Kivu. Three species of *Barbus* of the Tanganyika drainage, of which only one lives in the lake, *Labeo cylindricus*, and the riverine *Amphilius platychir* are the only species which have almost certainly come from the East and South African fauna. The Nyasan fish fauna has been largely recruited from the relatively poor East and South African fauna. The dominance of *Barbus* here is reflected in the fact that Lake Nyasa has twice as many species as Lake Tanganyika. Only a single Nyasan species *Barbus banguelensis* occurs in the Congo system. The interpretation of this distribution has been discussed. The cichlid stocks were probably also derived from the East and South African faunas.

In the discussion of the species associations of the copepods of the genus *Eucyclops* the four endemic species were considered to form a flock which had evolved in the lake. The presence of three other non-endemic species of the same genus provides evidence of passive multiple invasions. Two of these, originally described by Sars from Lake Tanganyika, have been subsequently discovered elsewhere. *E. agiloides* (Sars) has been recorded from many other places in Africa, southern India, and the Sunda Islands (Kiefer, 1929, 1932, 1934a, b, 1939). *E. euacanthus* (Sars) is known to occur in western and southern Africa and in the Sunda Islands, (Kiefer, 1929, 1934a, b, 1939). The third species, *E. angustus*, originally described from Lakes Tanganyika and Nyasa, has not been taken elsewhere. The unmodified populations of *E. agiloides* and *E. euacanthus* may be relatively recent invasions. It is possible that the species of *Eucyclops* and *Microcyclops* now considered endemic in Lake Tanganyika may also be shown to exist elsewhere as the tropical freshwaters of the Old World become better known.

SPECIES ASSOCIATIONS IN OTHER LAKES

Large species associations have been discovered in five other lakes. None of these associations approach in magnitude those found in the three lakes previously considered. The fauna of only one of these lakes, Victoria Nyanza, is sufficiently known to merit discussion. It has one large species association. Lake Titicaca, high in the Andes, has two species associations. Insufficient data on the intralacustrine distribution of the faunal elements are at present available. The complete results of the Percy Sladen Trust Expedition to Lake Titicaca in 1937 will undoubtedly provide much of the desired information. The other three lakes are smaller in size and have smaller species asso-

ciations. Lake Lanao on Mindanao in the Philippine Islands is reported to have at least 17 closely related species of cyprinids in its waters. Lake Ochrid, lying near the junction of Greece, Jugoslavia, and Albania, has in its fauna several small species groups. Species associations have been reported among the prawns, molluscs, and fish common to the five small lakes of the isolated Malili River drainage of central Celebes.

Lake Victoria or Victoria Nyanza

The basin of Lake Victoria is about as different in shape from those of Baikal, Tanganyika, and Nyasa as could be (Fig. 6). It is like a tremendous saucer, with an area of about 69,000 sq. km. (26,000 sq. mi.), and a maximum depth of 80 m. Even this depth is exceptional, and over most of the central portion of the lake no depths of more than 70 m. can be found. The coast line is extremely irregular, with many small bays and islands near the shore. There are three large gulfs, Kavirondo Gulf in the northeast part, Speke Gulf to the southeast, and Emin Pasha Gulf to the southwest. The only regular stretch of shore is along the west side of the lake. The Sesse Islands form an archipelago in the northwest corner of the lake.

Worthington has studied (1930) the physics and chemistry of the lake water, and found a striking difference between the gulfs and the open waters of the lake. The transparency of the open waters measured with Secchi's disc varied between 6 and 8 m., while in Kavirondo Gulf, which was assumed to be a typical gulf, the transparency was from one half to one-and-one half m. The great turbidity of the gulf is due to two factors. Phytoplankton is more abundant and there is a considerable amount of suspended detritus, as these gulfs are shallow enough (10–20 m.) to be mixed to the bottom. The temperature of the gulfs tends to be slightly higher than the upper layer of similar thickness in the open part of the lake where the temperature is about 25°C., dropping gradually to 23.3°C. at the bottom. Complete diurnal mixing takes place in the upper 20 m. of water, which are probably saturated with oxygen, although no determinations were made. Water below this depth is never fully mixed, according to Worthington, although there is sufficient secondary turbulence to maintain a low oxygen concentration on the bottom, which is inhabited chiefly by chironomid larvae (Worthington, 1930). A few oligochaetes and prawns apparently can exist here as well (Graham, 1929). The deeper parts of the bottom in the gulfs are also populated primarily by chironomids.

The fauna of Victoria Nyanza has been catalogued by Cunnington (1920) and, except for the fish, there have been few changes or additions since. The faunas of both Victoria Nyanza and Lake Kioga are very different from that characteristic of the Nile. There is good reason to believe that Victoria Nyanza, like Lake Edward, was reduced to a swamp-like condition during the first interpluvial period. This extreme reduction of the former lake caused the extinction of all but a few Nilotic species. Since Lake Victoria has refilled, its waters have been repopulated from the survivors with a few additions from adjoining waters. Murchison Falls has prevented the invasion of Nilotic fish. The most recent list of the fish, given by Graham (1929), includes the new species collected by the Fisheries Survey of 1927–1928. Several small species associations among the invertebrates are undoubtedly the result of multiple invasions. By far the largest association within the lake is that of the genus *Haplochromis* and a few closely related fish placed in other genera. This is a species flock. Graham's list gives 55 endemic species of *Haplochromis* and one Nilotic species, *Haplochromis multicolor* (Hilg.). In addition to these, Regan (1922) has separated four deviant species of the *Haplochromis* stock into four genera, *Astatoreochromis*, *Macropleurodus*, *Hoplotilapia*, and *Platytaeniodus*.

Subsequent to this survey of Victoria Nyanza, the Cambridge Expedition to the East African Lakes explored several lakes directly to the west of Victoria Nyanza and discovered *Haplochromis* populations very similar to those hitherto considered as endemic to Lake Victoria. The most westerly and by far the largest of these lakes is Edward, occupying a downwarp of the Western Rift. The other lakes are small and swampy, and constitute part of one of the peculiar drainage systems which drain both east into Victoria Nyanza and west into Lake Edward (Fig. 6). Those investigated are Nakavali, Kachira, and Kijanebalola (Worthington, 1932). The non-cichlid fish were treated in 1932 by Worthington, and Trewavas published an account of the cichlids in 1933. Twenty species of *Haplochromis* were found in Lake Edward, four of them species previously thought to be restricted to Lake Victoria.

This close relationship is further emphasized by the fact that the 17 endemic species in Lake Edward are all closely related to Victoria species. Two other cichlids from Lake Edward belong to monotypic genera clearly derived from *Haplochromis*. One is *Astatoreochromis alluaudi* Pell., common in Victoria, while the other, *Schubotzia eduardiana* Blgr., occurs only in Lake Edward. An examination of the fish of the three small, swampy lakes proved that *Haplochromis nubilus* Blgr., one of the few species common to Edward and Victoria, also occurs in all three small lakes, and that *Astatoreochromis alluaudi* occurs in two of them.

The recent fish fauna of Lake Edward has obviously been derived from Victoria by means of the drainage systems connecting the two lakes, rather than from Lake Albert through the Semliki River, which drains Edward. During the early Pleistocene Lake Edward contained Nilotic fauna, judging from the fossil remains of crocodile and *Lates* in the Kaiso beds near the lake (Fuchs, 1934). The present fauna lacks these Nilotic elements, which are presumed to have been destroyed during the arid first interpluvial period. The Semliki Falls has acted as a barrier to the passage of the Nilotic fauna from Lake Albert into Lake Edward just as the Murchison Falls has prevented its penetration into Lakes Kioga and Victoria.

The *Haplochromis* species of this Victoria-Edward system differ from each other primarily in the size and shape of the mouth and the number, structure, and arrangement of the teeth, and appear to form a natural group which has probably evolved from a single population. Trewavas (1948) has expressed the belief that this parental species resembled *H. wingatii* of the Upper Nile and *H. bloyeti* of Tanganyika Territory.

Although fish of the *Haplochromis* stock have speciated tremendously in Victoria Nyanza, it will be remembered that there are almost twice as many species in the Lake Nyasa flock. Regan, who has studied the cichlids of all three lakes, has considered that those of Tanganyika are more differentiated than those of Nyasa, and these in turn more so than those of Victoria Nyanza. This is in accord with the geological evidence that Tanganyika is the oldest and Victoria Nyanza the youngest of the three lakes.

A consideration of the known facts about the ecology and distribution of the *Haplochromis* flock within Victoria Nyanza brings to light a most baffling problem, since many species are not restricted to the bottom, as was true of all of Lake Baikal's species flocks. Although a large part of the fish population occupies the inshore waters, especially the gulfs, many *Haplochromis* are found in the open waters as well, feeding chiefly upon the smaller *Engraulicypris*, a plankton-feeder. The same species also feeds on the bottom at shallow, intermediate depths, and a few may even feed on the deepest bottom. Indeed, Graham has concluded that one species, *H. guiarti*, is ubiquitous except perhaps in water deeper than 60 m.

The first step in an investigation of speciation in Victoria Nyanza is to determine whether there are any species of *Haplochromis* which are restricted in distribution to any geographically distinct regions of the present lake. Although there have been no studies directed primarily toward the elucidation of the *Haplochromis* distribution, the Fisheries Survey made 100 collections with different types of gear in many parts of the lake. The results of these collections have been reported in some detail (Graham, 1929) and it is possible to obtain some conception of the distribution of many species.

The majority of the species, while not frequently caught, were taken at widely separated points, so that a lake-wide distribution must be assigned them provisionally. Two species are not only widely distributed but also numerous, inasmuch as they are represented in a large number of catches. *H. guiarti* was present in a third of all collections, being taken most frequently in 2-inch mesh gill nets in both deep and shallow water, and in trawls and seines as well. This species apparently is present in all parts of the lake, with the possible exception of water deeper than 60 m. *H. cinereus* was taken in one-fifth of all collections, most frequently in trawls, indicating that it stays much closer to the bottom than *H. guiarti* does. This species certainly shuns the deepest bottom. *Astatoreochromis alluaudi* is among the most common, appearing in one-seventh of the catches.

Although it is reasonable to assume a lake-wide distribution on the basis of a small number of widely scattered collections, greater caution must be used in assuming a restricted distribution from a single catch. Eight species of *Haplochromis* were taken at single stations. Four of these, each with a single specimen taken, were collected in the northwest corner of the lake. In view of the fact that a greater number of collections was made here than

anywhere else in the lake, these catches may only represent chance catches of species more widely distributed but rare everywhere. However, one species, *H. plagiostoma*, was taken six times around Kavirondo Gulf and near Port Victoria just to the north. A single specimen was taken in each of three gill nettings, yet two were taken in a trawl near Port Victoria, seven in a trawl in Kavirondo, Gulf, and five from a basket trap near the Rusinga Islands at the mouth of the gulf. It seems likely that this species has a restricted distribution, although it is still far from certain. Another species *H. sauvagei*, was taken on three occasions near Port Victoria, twice in trawls yielding one and 18 specimens respectively, and once a solitary specimen in a gill net. Here again, it is likely but not certain that this species has such a limited range. Similar difficulties are attached to the interpretation of the single catch of single specimens of two other species in parts of the lake which were less intensively fished. The data for *H. bayoni* are more convincing. This species was taken four times in gill-nettings around the Sesse Islands and the islands of Damba and Kome just to the north and no where else. Although three nets held solitary specimens of *H. bayoni*, 20 were caught in the fourth. At present the interpretation that *H. bayoni* is confined to the waters around these islands of the northeast coast of the lake seems justified. Two other species, *H. argenteus* and *H. gowersii*, were each represented by single specimens in this much less intensively fished region and may similarly be restricted to it.

This appears to be the only portion of the lake to which some species are limited. The large gulfs, with the possible exception of Kavirondo, do not seem to be sufficiently isolated for their populations to have diverged genetically. It is not unexpected, in view of Worthington's observations, that the biota is dense in the shallow waters all around the lake.

Worthington's observations on Lake Nabugabo assume importance because they furnish a clue to the way in which *Haplochromis* populations can be isolated and diverge sufficiently to attain the rank of separate species. What is now called Lake Nabugabo was once a bay on the northeast coast of Victoria Nyanza (Fig. 6), but in the course of time the strong southeast winds have built a sand spit across its mouth which ultimately separated it completely from the body of the main lake (Worthington, 1933). Lake Nabugabo now contains *Tilapia*, *Clarias*, *Bagrus*, and *Haplochromis*. The species of the first three genera are the same as ones found in Victoria; however, only one of the four species of *Haplochromis* is a Victorian species, the others being endemic to Lake Nabugabo. Each is, however, closely related to a species in Victoria (Trewavas, 1933). Should this lake become continuous with Lake Victoria again, as a rise of several meters in the water level would certainly bring about, these Nabugabon species would be placed in competition with those already in Victoria. Such competition would lead to ecological specialization, because any genes which tended to lessen the degree of competition between the competing species would have selective advantage. Competing species would tend to occupy different ecological niches.

Lake Nabugabo, therefore, provides an illustration of the manner in which both benthic and pelagic species of *Haplochromis* can have arisen. The isolation of bays to form small peripheral lakes, which were subsequently reincorporated after a period of isolation short relative to the age of the main lake, could account for the origin of the *Haplochromis* flock. The main body of Victoria Nyanza would then be comparable to a large central island in an archipelago that accumulates species which have attained reproductive isolation on the smaller peripheral islands (Galapagos finches or Hawaiian drepanids, for example). Competition between these species leads either to changes in habit which reduce competition, or to extinction.

Geological observations indicate that the lake has been much more extensive in the past than it is at present (Wayland, 1934). Ancient shorelines extended as far as the rifts to the northwest and southeast. Beaches as far as 300 feet above the present lake level have been found. This does not necessarily mean that a lake 300 feet deeper than the present one ever existed, as the basin has very likely been tilted several times during the course of its history. However, it is clear that the lake has been more extensive than now and that its level has fluctuated considerably. This would afford ample opportunity for the isolation of peripheral lakes and their reincorporation.

The fact that the species of *Haplochromis* in Lake Nabugabo have diverged sufficiently to be considered specifically distinct, while the other populations have not become modified, indicates the relatively rapid rate at which *Haplochromis*

can evolve. As mentioned during the discussion of the Nyasan cichlids, the reproductive behavior of these fish may be responsible for the preservation of differences which arise during temporary isolation (cf. p. 140).

If the *Haplochromis* stock has long been characterized by complex reproductive behavior, the period of isolation of a peripheral lake could have been relatively short and still sufficient for the isolated population to become so modified that it would be reproductively isolated when reintroduced into the main body of the lake. Also, from the absence of species flocks among the other genera, which appear to diverge more slowly, it may be deduced that the peripheral lakes which were reincorporated into the main lake had in general not been isolated for geologically long periods.

Estimates of the age of Lake Victoria vary considerably. Worthington (1937) has probably underestimated it at 15,000 to 20,000 years. According to Wayland (1934), a lake which existed at the same site during the early Pleistocene dried up more or less completely during the interpluvial period between his Pluvial I (Kageran) and Part 1 of Pluvial II (Kamasian). The lake reformed during the Kamasian pluvial. Wayland considered that the arid period succeeding the Kamasian pluvial was not sufficiently intense to cause this lake to lose its lacustrine character, although its size certainly dwindled. If his interpretation is correct, then Lake Victoria has persisted since the Kamasian pluvial. Kamasian is considered Middle Pleistocene (cf. Leakey, 1936) and contemporaneous with the Riss Alpine glaciation. The age of Lake Victoria would then be about 300,000 to 500,000 years, depending on the estimate of the total length of the Pleistocene. If, however, the lake did dry up during the Kamasian-Gamblian interpluvial, the present lake must have formed early in the Gamblian pluvial, or between 50,000 and 200,000 years ago. It is unlikely that any subsequent arid phases were sufficiently intense to bring about the desiccation of the lake.

According to Wayland's map of the region adjacent to Victoria Nyanza (1934, p. 349), there are two small lakes to the west of the southern half of the western coast of Victoria. These lakes, Ikimba and Burigi by name, are possibly other examples of peripheral lakes left by a shrinking Victoria and are worthy of investigation.

Lake Titicaca

Lake Titicaca has a total area (excluding islands) of 7600 sq. km. (Gilson, 1939). The main basin or Lago Grande is roughly elliptical with the major axis NW—SE. The maximum depth has been recorded at 281 m. At the southeast end of the main basin, connected by a narrow strait, is a shallow bay, Lago Pequeño. Shallow Puño Bay on the northern half of the western side of the lake is the only other major irregularity in the shoreline. The lake lies between 15° 14′ and 16° 35′ S., at an altitude of 3815 m. The lake is within a basin of internal drainage called the Altiplano, a downfaulted area between the Eastern and Western Cordilleras which extends from 14° to 22° S. To the south of the Titicaca basin there is another basin within the Altiplano which contains water. This is Lake Poopo, a vast brackish puddle with an area of about 2500 sq. km. and a depth of seldom more than 4 m. Titicaca drains into Poopo through the sluggish Desaguadero River. South of Lake Poopo, at the southern end of the Altiplano, there are vast salt flats.

At the northern end of the Lago Grande, and separated by only a few kilometers, are several small, probably shallow lakes, the largest of which are Lakes Arapa and Umayo. Arapa connects with the Rio Ramis, a few kilometers above its opening into Lake Titicaca. Umayo is west of Puño Bay. As these lakes are only a few meters higher than Titicaca, it is certain that they were until relatively recently a part of the large lake. These peripheral lakes are thus similar to those believed to have been important to the speciation of *Haplochromis* in Lake Victoria. Of quite a different nature are two lakes, Lagunilla Lagunilla and Lagunilla Saracocha, about 80 km. (50 mi.) west of Puña in the Western Cordilleras. They are about 300 meters higher than Lake Titicaca and were undoubtedly always separate from it, although it is probable that they have been connected with each other at some time in the past.

Moon has reviewed the history of the Altiplano (1939). During Miocene time tectonic movements led to the formation of the Altiplano, which has been a basin of internal drainage ever since. During the Pliocene the Altiplano was only a few hundred meters above sea level and supported a semitropical biota. Chiefly during the early Pleistocene the basin suffered uplift to its present elevation and without lateral displacement, and became increasingly arid the while. There are

abundant indications of much higher lake levels, some or all of which have been attributed to the melting of glaciers during the Pleistocene. The Titicaca and Poopo basins were probably united in a large lake at one time.

A paucity of animal stocks comprises the biota of Titicaca. Although several widely distributed groups are represented by many cosmopolitan species (rotifers for example, recently treated by Beauchamp, 1939), there are only two piscine stocks. One siluroid, *Trichomycterus rivulatus*, inhabits the waters of the Titicaca basin as well as those of other parts of Peru and Bolivia (Tschernavin, 1944b). A cyprinodont stock is represented by 18 species in the Altiplano. Two of these 18 also occur in river systems draining the outer sides of the mountains rimming the Altiplano. Only two species do not occur in the Altiplano, each of them being restricted to a lake in the valley to the north of the Altiplano, that of the Urubamba River. These 20 species are considered to constitute the subfamily Orestiinae. Their geographical distribution indicates that the Altiplano has been the site of their evolution, and they are the most remarkable element of its biota. The only other vertebrates in Lake Titicaca are the entirely aquatic frogs of the Andean genus *Telmatobius*.

Not only are the amphipods the only group of malacostracans described from Titicaca, but they are the most interesting of all its crustaceans. The planktonic cladocerans and copepods (Birge, 1906; Marsh, 1906) show nothing remarkable from the point of view of a student of evolution. Unlike those of Baikal, these amphipods are taltrids and the 11 species described belong to *Hyalella* Smith, a genus characteristic of the freshwaters of both North and South America and the sole amphipod genus so far known from continental South America (Shoemaker, 1942). More will be said of this species association.

According to Bavay (1906), nine genera of molluscs are represented in Lakes Titicaca and Poopo. Two genera appear to have species pairs. All other genera are represented by single species. It seems advisable to defer discussion of these molluscs until the latest collection has been studied.

The three species associations to be considered are those of the Orestiinae, *Hyalella* and *Telmatobius*. Tchernavin's thorough study (1944a) of the taxonomy of *Orestias*, together with the little that is known of the ecology and distribution of its species, has made it possible to comprehend the problem involved. Tchernavin has arranged the 20 described species into four groups which are of generic or subgeneric rank. Not all four groups are equally well defined. Group II is the largest, with 8 species, all rather large in size and inhabiting streams, rivers, pools and lakes not only within the Altiplano but also to the north as far as Lake Junin, Peru, and southward to Lago d'Ascotan, Chile, west of the southern end of the Altiplano. Groups III, IV, and I, with 6, 4, and 2 species represented, respectively, are restricted (with one questionable exception) to Lake Titicaca. The two large-sized species of Group I are the only pelagic members of the subfamily, according to Tchernavin. The origin of these two closely related pelagic species must date from a time when Titicaca was subdivided into at least two separate basins. A few specimens in which the characteristics of the two species are curiously combined have been considered hybrids by Tchernavin. Garman described with great inexactitude a "variety" of one of these species, *O. pentlandii*, from the Urubamba River to the north of the Altiplano. Tchernavin has not included this "variety" of Garman's because of the inadequacy of the description. It is inherently improbable that one of the pelagic species from Lake Titicaca could have passed over the mountain range separating the two drainage systems, although headwater species certainly have done so.

The members of Group III, all of small size, occur in the shallow waters of Lake Titicaca. Tchernavin considers this a rather artificial grouping. The four species of Group IV, on the other hand, apparently constitute a well-defined group which might be considered a genus. All species have been taken from greater depths of the lake than have any of the other species, viz., between 20 and 38 m.

All these species have undoubtedly originated within the Altiplano through geographical isolation.

The report on the amphipods taken by the Percy Sladen Trust Expedition has not yet appeared. Our knowledge of this group is based upon Faxon's 1876 report on the collections of the Agassiz-Garman Expedition of 1875 and Chevreux's (1906) study of Neveu-Lemaire's collections made in 1903.

All 11 described species are members of the bottom communities of Lake Titicaca. None have been reported from saline Lake Poopo or any of

the other freshwaters of the Altiplano. Little is known of the intralacustrine distribution of the species. Agassiz and Garman collected from considerable depths (as great as 120 m.) several species which in their spinosity bear a resemblance to certain of the Baikalian gammarids. Neveu-Lemaire did not succeed in making collections at any great depth. The four new species which Chevreux described occur in shallow water, and four of Faxon's deep-water species were not retaken by the second expedition. It is probable that these species comprise a flock which had its origin in the lake.

Telmatobius is more like *Orestias* than *Hyalella*, in that there is a widespread Andean fluviatile species ***T. marmoratus***, which inhabits most of the rivers and streams within the Altiplano. Morphological comparisons accord with the distributional evidence in indicating that this species is more primitive than the two lacustrine species which are restricted to certain lakes of the Altiplano. One of these, ***T. culeus***, occurs in its typical form only in the Lago Grande. However, a distinctly different form, *T. c. albiventris*, inhabits Puño Bay, Lago Pequeño, and Lake Arapa. The populations in these three geographically discontinuous shallow waters are closely similar. Parker (1940) was unable to decide whether these three populations are relicts of a population continuous in the recent geological pst, when the lake was higher, or whether they represent three geographically separate divergences from a population like the typical form. The second lacustrine species, ***T. escomeli***, lives in the two Lagunillas to the west of Lake Titicaca. It will be remembered that these lakes are about 300 m. higher than Titicaca and probably were never connected with the lakes occupying the floor of the Altiplano. This species has apparently arisen from ***T. mamoratus*** independently of ***T. culeus*** in a lake which probably included the two present lakes. Each of the two present Lagunillas has a peculiar subspecies.

Lake Ochrid

This brief notice of the evolutionary problems presented by the fauna of Lake Ochrid is based primarily upon information marshalled by Stanković (1932) in his review of the data concerning the lake and its fauna.

Lake Ochrid lies on the Albanian-Yugoslav border and is small relative to those with which we have been previously concerned. Lake Titicaca is by far the smallest of these, and its Lago Grande alone covers an area over 20 times larger than Lake Ochrid (270 sq. km.). However, Ochrid matches Titicaca in depth. Its maximum depth, 286 m., is five meters greater than any yet found in Titicaca and, like the Lago Grande, much of the bottom lies under more than 200 meters of water. For its size Ochrid is relatively deep. Its basin is regular and steep-sided. In some places it is possible to sound 230 m. only 300 m. from shore! All geologists who have studied the region agree that the lake occupies a graben formed or, at least rejuvenated, by recent down-faulting. The amount of surface run-off in the steep-sided depression largely occupied by the lake is small, most of the water being supplied by numerous and large springs both above and below the surface of the lake. The northern rim of its elliptical basin is low and over it the lake finds its outlet as the Drim River, flowing northward through Albania to the Adriatic Sea.

The fauna of Lake Ochrid is not only distinguished through the presence of a fair proportion of endemic subspecies and species, but also the majority of stocks are not those found largely expanded throughout the freshwaters of western Eurasia.

A consideration of the fish fauna of Ochrid is illustrative. Thirteen of 18 populations are taxonomically distinct. Ten of these are represented by populations best considered geographical subspecies. Two populations restricted to Ochrid are specifically distinct. A third is restricted to the Drim system (including Lake Scutari). There is not even one species pair, let alone any flocks in Ochrid, in which aspect this lake differs from all of those previously considered. The fish fauna of that part of the Balkans draining into the Adriatic is distinct from that of the Danube basin and central Europe and even from that of the Balkans whose rivers flow into the Aegean. The western part of the Balkan peninsula most resembles southern Europe in the composition of its fish fauna, yet shows some indication of similarity to the freshwaters of northeastern Asia. The two salmonids of Lake Ochrid illustrate these patterns of distribution. Endemic *Trutta balcanicus* was considered by Karaman (cited in Stanković, 1932) to be similar to ***T. carpio*** of Lake Garda (Northern Italy). Berg (cited in Stanović, 1932) placed the other endemic salmonid together with *S. obtusirostris*, a Dalmatian endemic, in the genus *Sal-*

mothymus, which he related to the Siberian *Brachymystex*. The nearest relatives of at least two west Balkan genera of cyprinids (*Paraphoxinus* and *Leuciscus*) which occur in Lake Ochrid are to be found in northeastern Asia (Berg, in Stanković, 1932).

It has been previously mentioned that 13 of the 16 known species of the oligochaete genus *Lamprodrilus* live in Lake Baikal. One of these, *L. pygmaeus*, also occurs in Ochrid as a subspecies. This remarkable link between Ochrid and Baikal has a parallel in *L. isoporus*, which was considered a Baikalian endemic until Svetlov (1936) reported a subspecies from Lakes Ladoga and Onega of Baltic Russia. The three species which do not occur in these lakes live in northeastern Siberia, Macedonia, and Bohemia, respectively, which distribution strenghens the faunal similarity between the Balkan region of Europe and the northeastern part of Asia.

The rissoid (hydrobiid) snails of Lake Ochrid show southern European, Siberian, and also Ponto-Caspian affinities. *Pyrgula* (*Pyrgula*), which is represented in Ochrid by three species, is known to have only one other extant species, and that from Dalmatia and Lombardy. Two other rissoids, *Trachyochrida filocincta* and *Stankovicia baicaliiformis*, are said to be allied to the Caspian *Micromelania* and the Baikalian *Baicalia*, but the degree of affinity is uncertain, not only because the taxonomy of this entire assemblage of rissoid snails is unsatisfactory, but even more because both species are known only by empty shells (Polinski, 1932).

As certain of the Ochrid stocks with relict distributions are also found in other Balkan freshwaters, Lake Ochrid cannot be regarded as a solitary stronghold where ancient species have maintained themselves against recent invaders. It is, on the contrary, but a part of the freshwaters of the Balkan peninsula, which with their tremendous subterranean ramifications have been able to resist faunal changes.

Our chief interest lies with the larger species associations of Lake Ochrid. Many are clearly associations which owe their origin to multiple invasions. Georgevitsch (1906) reported four species of the hygrobatid watermites of the genus *Piona* from Ochrid, all non-endemic. Two species of amphipods both belonging to the same subgenus of *Gammarus* live in Lake Ochrid. *G.* (*Rivulogammarus*) *ochridanus* is an endemic representative of *G.* (*R.*) *balcanicus* which occurs in the Balkans, Crimea and Asia Minor. The other species is *G.* (*R.*) *roeselii*, a central European form which extends into the Balkans (Schellenberg, 1937, 1943). The tubificid oligochaete *Peloscolex* is represented in Lake Ochrid by two species, *P. stankovici* and *P. tenuis* (Hrabě, 1931). *P. stankovici* is an endemic species most closely related to the European *P. velutinus*. *P. tenuis* also occurs in Lake Prespa, a shallow lake several km. to the southeast of Ochrid and, according to at least one geologist, once continuous with Ochrid. *P. tenuis* approaches the European *P. ferox* most closely and apparently represents an invasion by this parent species or its ancestor relatively early in the history of Ochrid.

Several other species associations can probably be attributed to multiple invasions, but the possibility of intralacustrine speciation cannot be eliminated. The most interesting example is that presented by another tubificid genus, *Ilyodrilus*, with three species in Ochrid. *I. hammonensis* is widely distributed throughout Europe, including Lake Prespa. Endemic *I. ochridanus* is most like a population in Lake Prespa, considered as endemic, *I. prespaensis*. This and *Peloscolex tenuis* are the only recorded stocks which are restricted to these two lakes which may once have been united. The third species in Lake Ochrid, *I. isochaetus*, is also endemic. It has been impossible to surmise the relationship of these two endemics to other species of the genus. *I. hammonensis* and *I. ochridanus* are among the commonest oligochaetes in Lake Ochrid, but *I. isochaetus* occurred in only three bottom samples. However, in these three, the two common species were absent. If this distribution was not fortuitous, it is the only evidence that any closely related species in Ochrid have allopatric distributions.

A major taxonomic problem is presented by the existence of four oligochaete species which are represented by subpopulations with somewhat different but widely overlapping vertical ranges. These may have arisen either by multiple invasions or by intralacustrine cleavage. If these subpopulations indeed coexist, as they appear to, they must be reproductively isolated and probably should be considered species. They have been called "Forms." *Tubifex* (*Psammoryctes*) *ochridanus* f. *typica* is characteristic of the deep water of Lake Ochrid, being replaced by *f. variabilis* in the shallower waters, yet in shallow Lake Prespa *typica* alone occurs. This indicates that competition is important in limiting the vertical range. In *Rhyn-*

chelmis komareki, on the other hand, the difference between the forms is a matter of head shape, and has a precise parallel in the dimorphic Baikalian *R. brachycephalis*, in which species abyssal specimens have shorter, rounder heads. These might be merely environmentally determined differences in single populations. Hrabě has described three forms of *Peloscolex stankovicia* from Lake Ochrid. Adults of f. *typica* with 30–35 segments average 6 mm. in length. The majority of the *typica* occurred deeper than either of the others. Adults of *sublittoralis* ranged between 12–18 mm. in length with 60–70 body segments. A few specimens found at the very surface were 24 mm. long and had 115 segments. These Hrabě called *littoralis*. Whether this is a single polymorphic population or three separate ones can only be decided by careful investigation.

The last instance of a species with two Ochrid "forms" has several peculiar aspects. The species in question, *Eiseniella ochridana*, belongs to a lumbricid genus with amphibious habits. The two forms are *profunda*, with the male genital pores on the 13th segment, and *stankovici*, with the pores on the 15th; the former was found in bottom samples taken between 20–250 m., while the latter has been taken only between 40–100 m. The widely spread European *Eiseniella tetraedra* is the only lumbricid in which populations exist some of which have the male pores on the 13th, others on the 15th segment. Curiously enough there is another aquatic lumbricid in Lake Ochrid, one which was named *Allolobophora lacustris* by Černosvitov (1931), and which also occurs in two forms with the male pores on the 13th and 15th segments, respectively. Although this worm bears some resemblance to the previous one, Černosvitov decided that it most resembled *Allolobophora*. Yet he has pointed out the near impossibility of generic assignments in the Lumbricidae. The taxonomy and biology of these lumbricids need further investigation.

Intralucustrine speciation must be considered probable in the origin of associations in two genera of snails and one among the turbellaria. The prosobranchiate snail *Pyrgula* and the pulmonate *Gyraulus* have each an endemic subgenus in Lake Ochrid, in addition to several species. *Pyrgula* (*Pyrgula*) has three species endemic to Ochrid. Only one other living species of this subgenus is known, and it lives in Lombardy and Dalmatia. Although the only known extant members of the subgenus *Carinogyraulus*, four in number, are restricted to Lake Ochrid, the subgenus did not evolve in the lake, if the assignment of certain Miocene shells to this subgenus is correct (Stanković, 1932). The vertical distribution of the members of these two associations was given by Polinski (1932). *P.* (*P.*) *macedonia* inhabits the zone from 5–20 m.; *P.* (*P.*) *pavlovići* is characteristic of the zone from 20–30 m.; *P.* (*P.*) *wagneri* is an abyssal form living below 50 m. One species of *Carinogyraulus* lives in the upper 5 m. of water; another is chiefly found between 5–20 m.; the third is abyssal. The fourth species (*paradoxa*) was taken only once, in 1891. The horizontal distribution of these species is not known.

Stanković (1932) has recorded seven dendrocoelids (turbellaria) from Lake Ochrid and the springs feeding it. *Dendrocoelum lacteum* and *D. nausicaae* are known outside the basin, while the other five are restricted to it. *D. nausicaae* and the endemic species were ascribed by Stanković and Komárek (1927) to a new genus *Neodendrocoelum*, but Kenk (1930) has found no justification for this generic distinction, removing them to *Dendrocoelum*. It is not possible to determine whether the five endemic species of *Dendrocoelum* constitute a species flock. *D. jablanicensis* is restricted to a spring on the north shore of the lake and *D. st. naumi* appears to occur only in springs on the south shore, from data given by Stanković and Komárek (1927), although Stanković (1932) did not explicitly state, as he did for the former species, that it is restricted to springs. *D. nausicaae* and *D. maculatum* have been taken both in springs and in the littoral zone of the lake. *D. ochridense* alone is stated to occur only in the lake, and has been taken in dredges at depths of 40 and 108 m. From its name it may be assumed that *D. lacustre* occurs in the lake, but nothing further has appeared concerning its ecology.

Five closely related species of the ostracodan genus *Candona* constitute the only indisputable, large species flock in Lake Ochrid. Klie (1939) described these from the deeper areas of the lake bottom (below 10 m.). The members of the flock (*C. alta*, *media*, *trapeziformis*, *cristatella*, and *depressa*) are similar to the common European *C. neglecta*. Although Holmes (1937), in his study of the littoral ostracods, reported a few specimens of *C. neglecta* from depths of 10–30 meters, Klie did not find this widespread species in the samples which he studied. It is probable that Holmes' specimens actually pertain to an endemic species simi-

lar to *C. neglecta*. Two other non-endemic species (*C. candida*, *C. fabaeformis*) and one endemic (*C. triangulata*) have been reported from Ochrid, none of which are close to the *neglecta* group.

Two other genera of ostracods, *Limnocythere* and *Leptocythere*, are each represented by three closely related species in Lake Ochrid, these having probably evolved in the lake. *Leptocythere* was unknown from freshwaters until Klie (1939) described the three Ochrid species and a fourth from the Danube basin.

In the present state of our knowledge the *Candona* group of five species is the largest association in Ochrid which has probably arisen through intralacustrine cleavage, with one or two four-membered associations [*Carinogyraulus* and *Dendrocoelum* (?)] and several three-membered flocks. The general features of the vertical distribution of the members of some flocks are known and have been indicated, but the horizontal distribution has never been investigated for any, making it impossible even to hazard a guess about the nature of the geographical barriers involved. The maximum length of time within which these flocks have developed is uncertain. Probably the basin has held water since the late Pliocene, giving this lake an antiquity of the order of that of Lake Tanganyika.

Lake Lanao

Lake Lanao on Mindanao, Philippines, is slightly larger than Lake Ochrid, for it has an area of 375 sq. km. and a maximum depth of 300 m. (These dimensions given by Herre, 1933, are at variance with those of Halbfass, 1922, who stated the area to be 900 sq. km. and the greatest depth 112 m.) The cyprinids are the only remarkable element of the fauna, there being 17 closely related species of these fishes in Lake Lanao and the waters connected with it, whereas no flocks are known among the other groups which have been investigated, although single endemic species occur. From the collections of R. Woltereck, who visited the lake on his Wallacea Expedition, Brehm (1933a) described an endemic copepod which he named *Tropodiaptomus gigantoviger* for the two large eggs carried by the female. Balss (1937) described an endemic crab *Parathelpusa* (*Barythelpusa*) *wolterecki*.

Only the broad features of the geological history of this region of northwestern Mindanao are known, but it is apparent that Lake Lanao owes its origin to the damming of the headwaters of a mountain stream by a lava flow at some unknown time in the probably not too distant past. These impounded waters filled the deep ravine in which the stream had flowed, forming a lake deepest near the dam at the southern end. A trough, which was the river valley, trends north-south nearer the western shore. Great areas of shallow water, from 4 to 10 meters deep, extend out from the northern, eastern, and southeastern shores. The water has overflowed the northwest corner of the lake and runs, as the torrential Agus River, to the not far distant ocean. The lower course of the river is interrupted by the Maria Cristina Falls, which drop 65 meters (Herre, 1933). As Lake Lanao lies on an isolated plateau, it is completely cut off from the other freshwaters of the island.

The poverty of the fish stocks is marked. There are only two fish, an eel and a species of *Ophiocephalus*, in addition to the cyprinid species flock which Herre was certain has developed from a single headwater species. The eel has apparently penetrated the lake through underground channels which can be seen emerging at the foot of Maria Cristina Falls. The presence of underground channels is not surprising because that region of Mindanao is overlain coral rock. Herre believed that *Ophiocephalus striata* was introduced long ago by man, as has been done all over Malaysia.

Barbodes binotatus, a Malayan fish which has invaded the southern Philippines and spread over most of Mindanao, is considered the undoubted ancestor of the Lanao cyprinids, five of which exhibit sufficient morphological divergence to be placed in other genera. These three genera are distinguished from *Barbodes* primarily by the structure of the lower jaw. *Mandibularia resinus*, the species most divergent in jaw structure, is also a fish of entirely different ecological relations from the other members of the flock, for it "has taken to life in the boiling eddies and swirling mad torrent of the Agus, the outlet of Lake Lanao" (Herre, 1933, p. 160).

Herre constructed a phylogeny of the Lanao cyprinids and added what he had observed of the ecology of various lines. *Barbodes tumba* inhabits all of the mountain streams and lakes of the isolated Lanao plateau with the apparent exception of Lake Lanao itself. The adaptation of a species to life in the outlet has been mentioned. Four closely related species live in the clear water over bottom from 5 to 15 meters deep, from which grow

forests of *Potamogeton*. Two of the largest species of *Barbodes*, *clemensi* and *manalak*, which live in this same ecological situation in Lake Lanao, also live in other lakes of the Lanao plateau. At least one species, *B. baoulan*, is restricted to the deeper waters of Lake Lanao. Several other species dwell in the shallow muddy bays of this lake, which are tangled with aquatic vegetation.

Herre has been the only investigator of these fish and he presented his 1933 summary with the express purpose of interesting some student of speciation in this fascinating problem. So far no one has availed himself of this opportunity.

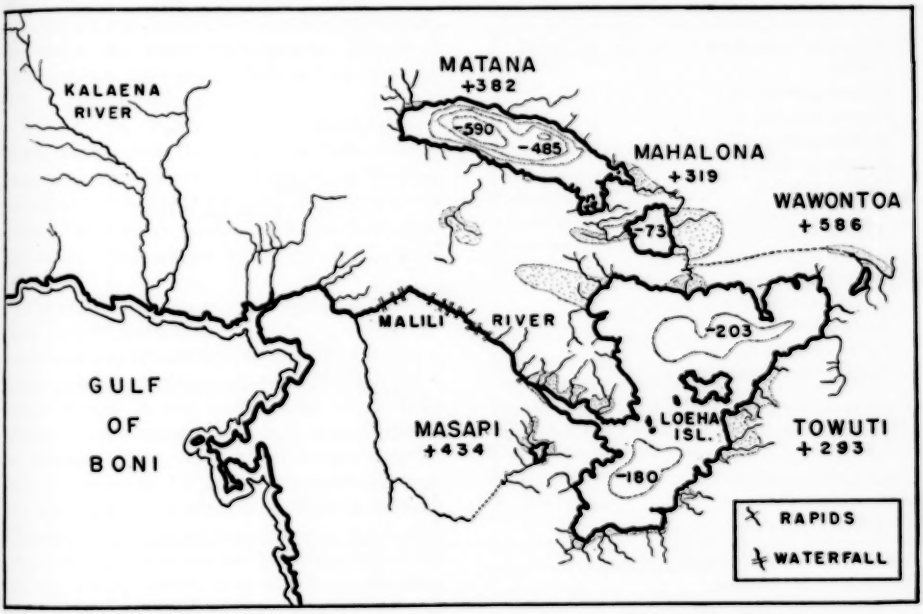

FIG. 8. LAKES OF THE ISOLATED MALILI RIVER SYSTEM, CENTRAL CELEBES (After Abendanon).

Lakes of the Malili River Drainage

The lakes of the Malili River drainage of central Celebes are different from all of the previously discussed old lakes because they form a system of lakes partially isolated from each other and completely isolated from other freshwaters. Most of the fauna is endemic, and many of the endemics belong to nine species flocks, all restricted to this lake system and having from two to eight members each. The members of a flock may inhabit the same lake or different lakes, or both.

As the connections between the lakes makes it likely that some lakes are more easily invaded than others, it is necessary to describe the lakes and rivers before considering the species flocks and their possible origins. Reference to the map (Fig. 8) will show that three of the five lakes, Matana, Mahalona, and Towuti, may be considered the central part of the system. The surface of Lake Matana is 382 m. above sea level and the relatively short Patea River which drains into Lake Mahalona descends 72 m., part of this drop occurring as a waterfall. The overflow from Lake Mahalona forms the Tominanga River which drains into Lake Towuti. The surface of Lake Towuti lies at an elevation of 293 m. The Tominanga River accomplishes this descent of 17 m. with only one series of rapids. Lake Towuti drains through the Malili River to the ocean at the head of the Gulf of Boni. There are 11 waterfalls along the upper half of the river's course. The two small peripheral lakes, Wawontoa and Masapi, are only indirectly joined with the central lakes. Wawontoa lies in the mountains to the east of Lake Towuti at an elevation of 586 m. and drains through an intermittent stream into the Tominanga River just

TABLE 10

Distribution of species flocks in lakes of Malili River system

SPECIES	MATANA	MAHALONA	TOWUTI	WAWONTOA	MASAPI
CRUSTACEA—PRAWNS (Woltereck, 1937)					
Cardina masapi	+	+	+	+	+
Cardina lanceolata	+	+	+		
Cardina loëhae	+		+		
Cardina spinata	+		+		
Cardina lingkonae†			+		
Cardina tenuirostris			+ (Lingkone)		
Cardina towutensis			+ (Southern end)		
*Cardina opaensis**	+				
CRUSTACEA—COPEPODS (Brehm, 1936b)					
Eodiaptomus wolterecki wolterecki			+		
Eodiaptomus wolterecki matanensis	+				
MOLLUSCA—PROSOBRANCH SNAILS (Kruimel, 1918)					
Melania palicolarum		+	+	+	
Melania masapensis					+
Melania patriarchalis } rare	+				
Melania gemmifera } hybrids	+				
Melania towutica			+ (Loëha)		
Melania towutensis			+ (and Tominanga River)		
Melania mahalonica		+			
Melania mahalonensis		+			
Melania abendanoni				+	
Melania sarasinorum			+(Loëha)		
Melania lalemae			+		
Melania tominangensis			+ (Tominanga River)		
Melania insulae-sacrae			+ (Loëha)		
MOLLUSCA—PELECYPODS (Kruimel, 1918)					
Corbicula matanensis	+				
Corbicula mahalonensis		+			
Corbicula towutensis			+		
Corbicula loëhensis			+ (Loëha)		
Corbicula masapensis					+
FISH—ATHERINIDAE (Aurich, 1935b)					
Telmatherina celebensis	+	+	+	+	
Telmatherina abendanoni	+				
Telmatherina bonti			+		
Paratherina wolterecki		+			
Paratherina labiosa				+	
Paratherina striata			+	+	
Paratherina cyanea			+		
FISH—CYPRINODONTIDAE (Aurich, 1935a)					
Aplocheirus marmotus		+	+		
Aplocheirus matanensis	+				
FISH—GOBIIDAE (Aurich, 1938)					
Glossogobius intermedius		+	+		
Glossogobius matanensis	+		+	+	
Stupidogobius flavipinnis			+		
*Vaimosa latifrons***	+	+	+		
Vaimosa sp.?			+		
	(13)	(11)	(26)	(7)	(3)

† pelagic.

* also in Lake Opa in SW. arm of Celebes.

** also in Kalaena River.

above the rapids. Lake Masapi is much more completely isolated, since its outlet, the Pongkeroe River, joins the Malili River below the cataracts. According to Abendanon's map, the Pangkeroe negotiates its descent of 434 m. without cataracts and its upper reaches are intermittent.

All of the animals represented by species flocks in these lakes tolerate fluviatile conditions. These lacustrine populations can presumably extend themselves downstream, and also upstream except over waterfalls. As we have no knowledge of other past connections or of how long the waterfalls of the extant rivers may have existed, we are forced to interpret the distribution of the species flocks in terms of the present physiography. The extent of Pleistocene sediments is indicated on the map (Fig. 8, stippled areas).

A tabulation (Table 10) of the distribution of these species flock indicates that Lake Towuti has more species than either Mahalona or Matana, as might be expected from its downstream position. The relative poverty of Lakes Wawontoa and Masapi is in accord with their relative isolation.

The presence of half as many species in Matana as in Towuti is not what would be expected if the fauna of Lake Matana had been derived from the lakes downstream. One explanation, namely, that Lake Towuti is the center from which Lake Mantana was populated at a time when there was no waterfall in the Patea River, is not consistent with the presence of the only non-endemic prawn, *Cardina opaensis*, in Matana but not in Towuti. The most reasonable assumption is that large, very deep Lake Mantana was one important part of the present Malili system in which the antecedent freshwater fauna of the region persisted during the tectonic movements which led to the formation and isolation of this portion of the Celebes. Although Lake Matana itself is of tectonic origin (graben), its formation probably dates from the initiation of these earth movements, while the remainder of the system was likely shaped by later movements. It is possible that some part of Lake Towuti also acted as a refuge for the antecedent fauna. The presence in Towuti of several groups of closely related species not represented in Matana (*Melania sarasinorum, M. lalemae, M. tominangensis, Corbicula towutensis, C. loëhensis, Paratherina*) can be adduced to support such a contention. However, their presence is as reasonably interpreted as the divergent results of early invasions from Lake Matana, possibly before Lake Mahalona was formed.

If it be assumed that Lake Matana is a center from which most if not all of the species flocks arose, it is then unexpected to find that Matana and Mahalona have no species which are common only to the two of them (cf. Table 10), although two species are common to these two lakes and Lake Towuti. It would appear that any species suf-

TABLE 11

Interlacustrine distribution of members of all Malili species flocks

(Based on Table 10)

MATANA—13 endemic species	
Matana only	7
Matana and Mahalona	0
Matana and Mahalona and Towuti	2
Matana and Towuti	2
All except Masapi	1
All five	1
	13
MAHALONA—11 endemic species	
Mahalona only	4
Mahalona and Towuti	4
Mahalona and Towuti and Wawontoa	1
All except Masapi	1
All five	1
	11
WAWONTOA—7 endemic species	
Wawontoa only	2
Wawontoa and Towuti	1
Wawontoa and Towuti and Matana	1
Wawontoa and Towuti and Mahalona	1
Wawontoa and Mahalona	0
All except Masapi	1
All five	1
	7
TOWUTI—26 endemic species	
Towuti only	15
(Single species with very close relatives in lake—3)	
Towuti species in Matana	6
Towuti species in lakes other than Matana	5
	26
MASAPI—3 endemic species	
Masapi	2
All five	1
	3

ficiently well adapted to fluviatile conditions to be able to spread into Mahalona from Matana is able to extend itself further downstream into Towuti and, in the case of two species, into other lakes as well. Further comment on the migration of species between lakes is unnecessary. The known facts are given in Tables 10 and 11, and their interpretation is left to the reader.

The apparent occurrence of intralacustrine speciation in both Matana and Towuti should be noted. There are four closely related species of *Cardina*, two of *Melania*, and two of *Telmatherina* in Lake Matana, where the possibility of multiple invasions has been fairly certainly excluded. In Lake Towuti the species mentioned previously as not occurring in Matana (3 of *Cardina*, 3 of *Melania*, 2 of *Corbicula* and 2 of *Paratherina*) have probably arisen within the lake.

A possible geographical basis for the intralacustrine speciation in Lake Matana is its subdivision into two basins. A major fault line, traceable as a scarp for many miles to the south, crosses Mantana between these two basins. The intralacustrine distribution of the fauna has not been studied. As Table 10 indicates, there is some evidence that members of the groups which have probably evolved in Lake Towuti have restricted distributions.

TABLE 12

Geographical bases of intralacustrine speciation

GEOGRAPHICAL CONFIGURATION	PROBABLE EXAMPLES	ORGANISMS INVOLVED	TYPE OF LAKE BASIN INVOLVED
Subdivision of the lake into large basins with subsequent amalgamation	BAIKAL TANGANYIKA (?) MATANA (?)	Benthic and pelagic	Deep lakes with multiple basins (graben en echelon?)
Formation of small peripheral lakes with subsequent reincorporation	VICTORIA NYANZA TITICACA (?)	Benthic and pelagic	Relatively shallow lakes in basins of low relief (small volume fluctuations or tilting produce great changes in area)
Long coastline with large, ecologically isolated stretches	BAIKAL TANGANYIKA NYASA	Benthic	Large elongate lakes

SUMMARY

Epitomizing this discussion of speciation in ancient lakes, it may be said that the gammarids of Lake Baikal are the only species flock the intralacustrine distribution of whose members is known with any degree of completeness. Many gammarid species and subspecies are restricted to geographically isolated and environmentally distinctive regions of the present Lake Baikal. The only reasonable explanation of their distribution pattern is that populations of these benthic organisms have been subdivided within the lake through the influence of geographical features. During their isolation these subpopulations have undergone genetic changes often of sufficient magnitude to effect reproductive isolation when the geograpical isolation breaks down. Subsequent interspecific competition results in the accentuation of adaptive differences. The high degree of ecological specialization which characterizes many lacustrine species flocks is thus attained through the competition of closely related species.

The restricted distribution of other species of gammărids, not so correlated with the present configuration of the lake basin, is explicable on the assumption of a single complete barrier effective in the geologically recent past. A partial barrier now exists on the site of the postulated complete barrier.

The intralacustrine distribution of not a single species flock of the African rift lakes, Tanganyika and Nyasa, is known. However, a consideration of the configuration of the basins of these lakes makes evident the possibility that intralacustrine geographical isolation has been responsible for the development of species flocks in these lakes as well as in Baikal.

The geographical features involved in speciation in Victoria Nyanza are entirely different from those effective in the lakes previously discussed. Similar features may have been responsible for some of the speciation in Lake Titicaca.

No information is available concerning the geographical features which may have been involved in the formation of the species flocks of the smaller lakes, Ochrid and Lanao.

The isolated group of lakes of the Malili River system in the Celebes presents a geographical situation for the development of species flocks which is fundamentally different from that found in any of the single lake basins.

Table 12 summarizes the types of intralacustrine geographical barriers and their apparent influence on species formation in ancient lakes.

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PERSPECTIVES IN THE FIELD OF MORPHOGENESIS

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This article contains essentially the text of an address on "The Outlook in Morphogenesis" delivered by the author at the International Symposium on Morphogenesis held under the auspices of the Centre National de la Recherche Scientifique in Strasbourg in July 1949. A French abstract will appear in the Proceedings of the Symposium. Having the character of an essay, this paper does not aim to "cover" any particular ground. Topics and examples have been chosen for illustrative expediency, rather than on absolute merit. Citations of literature are confined, as far as possible, to recent reviews and monographs, and original articles are quoted only when special documentation appears to be particularly pertinent.

INTRODUCTION

MORPHOGENESIS is once more coming to the forefront of biological interest, and its future becomes of immediate concern not only to biology, but to medicine and agriculture as well. Progress in the field is vigorous and rapid, and although we cannot foresee whither it will lead us, we can tell by extrapolating from present trends the direction in which it is heading. The advance follows two main currents, the one aiming at the accumulation and analysis of data, and the other at the clarification of concepts. Morphogenesis is still in the transition phase from descriptive "natural history" to analytical science. In this transition, techniques have somewhat outdistanced concepts. Many of us use modern physical and chemical tools of great precision, but by applying them to problems formulated in the much less precise phraseology of an outdated era, we often end up with results that are equally unprecise and ambiguous.

It is necessary, therefore, to bring our problems up to date. Considering their complexity, this is no easy task. There are tendencies to circumvent the difficulty by arbitrarily divesting the problems of their natural complexity. Then, operating with these oversimplified constructs, which barely resemble the real phenomena, one is apt to arrive at conclusions that are equally far from reality. To those with a firsthand acquaintance with the facts, the oversimplified, often factitious and synthetic notions of growth and differentiation, which seem to guide some current applications of biophysics and biochemistry to problems of morphogenesis, appear remarkably unrealistic. The use of ambitious but loose terms such as "chemical organizers," "growth substances," "differentiation hormones," "embryonizing effects," and so forth, has become a common occurrence. Cancer research is bringing into the study of morphogenesis recruits in increasing numbers. Many of them innocently fall for such catchwords, laboring under the illusion that they are heading for key solutions to the riddles of development. They would gladly redirect their efforts if those closer to the facts were to give them more correct and more precise information as to just where the real problems lie and how they look in reality. To give a single example, it seems to me utterly misleading to continue to represent to the outsider "the induction of the nervous system" or "the action of the organizer" as if they were simple, single, unitary, and elemental processes, now that we have definitely established that they are not. One could enumerate a substantial list of similar misrepresentations which in the long run hamper progress because they obscure the issues which they purport to clarify.

To be sure, impressive progress is being made despite the traditional muddle in our concepts. This is due partly to the fact that those familiar with the phenomena have mentally outgrown the old-fashioned concepts and have made the proper adjustments and rectifications in their own minds as they went along, without making this explicit to the "outsiders." For instance, most of those who have thoughtfully worked on amphibian de-

velopment will readily admit that the term "organizer," which they use as a shorthand label for a known phenomenon, certainly does not deserve the universal connotation originally attached to it, of being the master principle of embryonic organization. However, those unfamiliar with the background and evolution of the problem misconstrue the term in just this sense and are accordingly misdirected in their thinking and even in their experimentation.

There can be no question but that the early boom of work on the "organizer" arose largely from the belief, or at least the hope, that it would bring a fundamental solution of the problem of embryonic organization. The very choice of the term bears this out. Serious arguments were voiced to discourage trust in a single and elementary solution of the problems of embryonic determination (Harrison, 1933; Weiss, 1935), and indeed, further work disproved the original one-sided connotation. The term "organizer" thus turned out to be a misnomer (Weiss, 1939a), yet, although this has been clearly recognized by many, including its originator, Spemann (1939, p. 367), common usage will not easily discard it in favor of a more pertinent and less pretentious term.

The situation in morphogenesis is not unlike that in gunnery. Even with the most perfect barrel and firing mechanism, hits will be few if the target either is blurred or moves around erratically. Therefore, future progress in the study of morphogenesis will depend significantly on whether or not we shall succeed in emulating the exact sciences by clearly marking and steadying our targets; that is, by describing the phenomena, problems, and results in objective, concrete, and unambiguous terms and units.

FORM AS FORMATIVE PROCESS

The first task along this line is to translate the conventional terms of descriptive morphology, largely gained from plain observation, into what might be called "instrumental terms." We must form the habit, for instance, of viewing the shape of a given cell, tissue, or organ not as a static feature, but as a phase, transitory or terminal, in a continuous chain of transformations; as a cross section through a stream of processes proceeding in time. Every morphological criterion is but an expression of antecedent processes that have contributed to its formation. Distance, in this version, becomes an index of past attractions, separations, intercalations, etc.; shape, other than spherical, the result of distortions due to elongation, secretions, shifts, contractions, expansions, differential growth, and the like; coloration, the result of chemical transformations yielding end-products which reflect and absorb certain wave lengths of incident light, plus such factors as aid in the production, destruction, accumulation, or dispersion of those chemicals. This is a way of thinking which, when applied to even the simplest process of morphogenesis, immediately reveals our dearth of exact knowledge. How does a cell layer double over to form a fold? How does a cell cord (e.g., the epimere) become cut up into segments? Is a forked structure due to collateral budding or terminal fissure? Does a solid cell mass become hollow by secretion, by cell resorption, or simply by elastic retraction? What are the differences, in terms of the underlying engineering processes, between a straight and a spiral tube, between a smooth and a corrugated surface, between anastomosing and blind arborizations? Innumerable such questions will have to be answered before we can turn our full attention to the broader issue of why things happen as they do.

The same need for more pertinent and precise description applies to the traditional concept of the cell. While cytochemistry, on the one hand, is bringing forth a wealth of detailed information (see Lison, 1936; Hoerr, 1943; Brachet 1945), common usage in embryology still has the cell "do" this or that, draws over-all balances of its activities and, in general, treats it as an elementary unit, overlooking its enormous inner diversity, heterogeneity, and variability. Although we acknowledge the existence of morphological subdivisions, such as the nucleus, nucleolus, cytoplasmic inclusions, mitochondria, and a membrane, we leave the matrix of the system, the so-called protoplasm, essentially unresolved. We generally concede to it "organization," but remain noncommittal as to the precise implications of this term. To the microscopist, whether he uses visible light or electron beams, protoplasm appears to possess a static mechanical framework as backbone of its organization. To the general physiologist, it is often no more than a colloidal solution contained in a more rigid membranous bag. The former view is hard to maintain in view of the great mobility of the cell content, while the latter view, of course, fails to explain how the orderly spatial segregation of the various disparate cell activities can be maintained without an under-

lying framework. We are faced here with an historical, but as yet unresolved dilemma. And since growth is essentially an increase in protoplasm, and differentiation a transformation of protoplasm, better insight into the nature of protoplasmic organization is prerequisite for the understanding of morphogenesis (see Seifriz, 1942).

MOLECULAR ECOLOGY

Mindful of this state of affairs, I have in recent years tried to sketch a concept of protoplasm which, however imperfect it may be, at least tries to present the cell in a more realistic and less symbolic light than before, and at the same time lends itself to experimental verification. This concept portrays the cell as a complex population of interdependent molecules and molecular complexes, whose behavior depends on the local physical and chemical conditions prevailing in the space which they come to occupy. These conditions assume the presence of an organized and relatively invariant pattern along all existing interfaces, such as the cell surfaces, nuclear surfaces, chromosome surfaces, surfaces of filamentous and globular cell inclusions, and so on, and this over-all order of conditions produces, preserves, and after disturbance restores the typical heterogeneous distribution of the various molecular species, despite their high degree of mobility. Since this concept of a "molecular ecology" of the cell has been treated more fully on previous occasions (Weiss, 1947; 1949a; 1949b), it may suffice here to quote the following summarizing statements.

"Each cell and organized cell part (nucleus, chromosome, etc.) consists of an array of molecular species whose densities, distribution, arrangement and groupings are determined by their mutual dependencies and interactions, as well as by the physical conditions of the space they occupy. These species range from the elementary inorganic compounds to the most complex 'key' species characteristic of a given cell. Chemical segregation and localization within the cell result from free molecular interplay, as only groups of elements compatible with one another and with their environment can form durable unions. The behavior of both developing and mature cells, as well as their restitution and regulation after disturbance, are faithfully described by this concept. . . . Among the principal segregative factors of molecular mixtures are interfaces. Interfacial forces between partly immiscible molecular populations concentrate certain selected molecular species of the interior along the border. By their surface positions, these border species acquire power over the further behavior of the enclosed system. This is due partly to their common orientation relative to the interface, which increases their structural coherence and chemical combining faculty, and partly to their control over substance exchange across the border. Various considerations suggest that in biological systems the fixation of a given molecular species in a surface is not due solely to unspecific factors such as surface tensions, adsorptions, etc., but that in addition, highly selective chemical affinities are involved. These may be based on the steric interlocking of characteristically shaped end groups of the surface molecules of adjacent systems." (Weiss, 1949b, p. 476).

I note that the concept of "molecular ecology" has found favor with some highly competent students of cellular biology (Monod, 1947; Lwoff, 1949, 1950; Schmitt, 1949). This seems to confirm its pragmatic value. Whether it will prove adequate, only the future can tell. Its main merit for the moment is that it presents us with a workable model of the cell by which the problems can be stated with greater precision; it helps us "focus our target."

One of its immediate effects is to show us a way of bridging the gap between chemical action and physical structure. Morphogenesis is the development of structures in space. Modification of morphogenesis by chemical agents has become a fruitful field of investigation (cf. Child, 1941; Needham, 1942; Lehmann, 1945). But while the effects of chemicals on some physical properties of protoplasm such as viscosity, fiber formation, cohesion, adhesion, etc., have been demonstrated, an exact knowledge of just how chemical action can produce or modify physical structures in such specific ways as are displayed in morphogenesis is still wanting. Here the concept of molecular ecology promises to furnish one of the missing links. For details, however, we must refer to the previous publications and some further comments made later in this article.

From these more general remarks let us now turn to the consideration of a few of the key problems in morphogenesis to see where some future advances have either already been inaugurated or can at least be reasonably expected. We shall single out for brief comment aspects of differentiation, growth, histogenesis, regulation, induction, and cellular reproduction, realizing the non-representative character of our arbitrary selection.

DIFFERENTIATION AND ITS CRITERIA

As I have pointed out on an earlier occasion (Weiss, 1949a), we must clearly distinguish between the process of differentiation on the one hand, and its visible criteria on the other. Most of the morphological criteria of cells and tissues usually described as "differentiations," as for instance contractile fibrils, pigment granules, secretion bodies, etc., are end products, hence indicators, of cellular manufacturing processes. Different end products indicate differences in their respective formative mechanisms. Such differences may be due to intrinsic differences in the constitution of the cells involved or to differences in the cellular environments. The critical test lies in transferring such cells to a common environment (e.g., tissue culture) whereupon, in the former case, they retain their distinctions, while in the latter case, they revert to a common type.

It has been found convenient to confine the term "differentiation" to the appearance of intrinsic and irreversible differentials among cell strains, in contradistinction to the varying and often reversible expressions which cells assume in response to different environments, and which have been termed "modulation" (Weiss, 1939a). In studying experimentally the case for and against true differentiations in this restricted sense, it has definitely been established that they are the rule in the various tissues of all mature higher animals. It has also been proven by the evidence of experimental embryology that the constitutional differentials among cell strains arise progressively during ontogeny. Cell strains from the same source and originally of identical character gradually assume divergent characters.

The diagram, Fig. 1, represents this situation in schematic form. It shows how cells of equivalent constitution derived from the same germ layer give rise to cell strains which have acquired different properties. These strains continue to dichotomize into further subdivisions until in the end the various specialized cell forms of the mature body appear. However, in the transition stages, as well as in the terminal stages, each cell is still capable of undergoing a variety of adaptive modulations in the course of which descendants of widely differing types may assume some morphological and physiological resemblance, without losing their type specificities. An example is the formation of phagocytic cell forms of the appearance and functional characteristics of macrophages (histiocytes), which can be obtained from muscle (Chèvremont, 1945), connective tissue (Bloom, 1937), glia cells (Weiss, 1944a), sheath cells of nerve (Weiss and Wang, 1945), yolk sac epithelium (Thomas, 1937), and perhaps still other tissues. The main point to remember is that in spite of assuming certain common functional aspects, the derivatives of these various

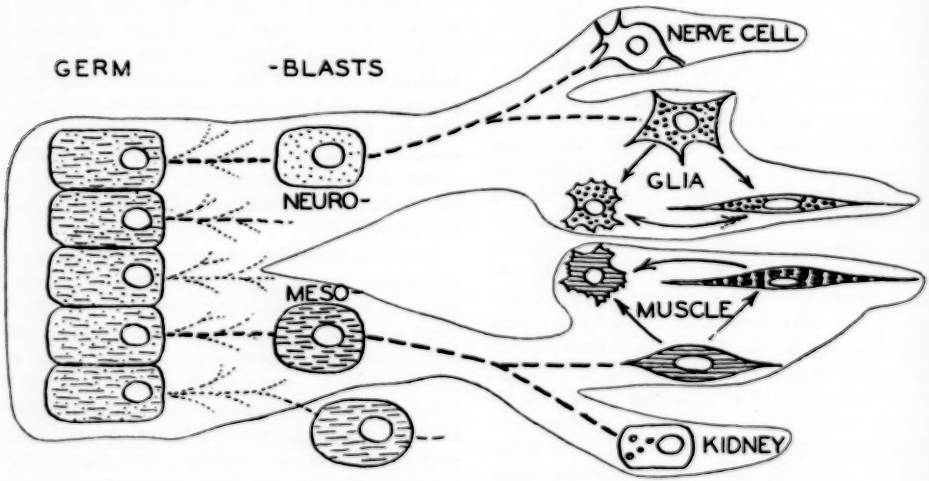

FIG. 1. DIFFERENTIATION OF FOUR CELL STRAINS, SOME WITH MODULATIONS INTO PHAGOCYTES

strains also retain some marked distinctions as indelible traces of their past ontogenetic differentiation.

In assessing the case for true differentiation, the mere retention of different specialized equipments in the very cells that were transferred to a common environment would not be crucial, for this could be ascribed to structural inertia. What makes the case conclusive is the fact that those cells proliferate many generations of new cells, and that these descendants, even though remaining in the common environment, continue indefinitely to carry the earmarks of their respective strains (Bloom, 1937, Thomas, 1938). While the occurrence of irreversible differentiation is thus an incontrovertible fact, the extent to which it occurs is an empirical problem, which has to be answered for each given case separately. The wide limits within which cell varieties of the mesenchyme, for instance, can still transform into one another marks them as modulations rather than subdifferentiations. This is strikingly corroborated by the study of regeneration in amphibians, in which the blastema cells derived from various mesodermal tissues of a given organ are equipotential (see Weiss, 1930). Those from a limb can produce all the mesodermal parts of a new limb, but not, for instance, of a new tail (Polejaiev, 1936), tail and limb mesenchyme as such being presumably true differentiations (contrary to earlier indications, Weiss, 1927; see Weiss, 1939a, p. 477). Recently, the startling claim has been advanced that most of the cells of a limb-regenerate spring from the epidermis (Rose, 1948). This would imply that adult epidermal cells after "dedifferentiation" give rise to muscle and cartilage. That the epidermis exerts some essential influence in the regeneration process has been known (Polezajew and Faworina, 1935); that some of its cells may escape into the blastema is quite credible; but from this to the assertion that they actually take part in the formation of the deeper limb tissues is a rather broad jump. Since this assertion is based solely on unconvincing observations and crude calculations, without crucial experimental support, it can hardly stand up in the face of overwhelming experimental evidence to the contrary, some of it (Hertwig, 1927), in fact, unreservedly quoted by Rose himself. It would take more convincing evidence to supersede the well-founded thesis that the various differentiated cell strains of the mature body are no longer equipotential and omnipotent.

By all judicious accounts, differentiation implies irreversible change. What remains to be determined is which part of the cell, or rather which fractions of its molecular population become transformed in the gradual process of specialization, and what other parts are exempted and persist in their primordial stage. We shall return to this point further below.

One of the difficulties with which we are faced in the study of cellular differentiation is the lack of more pertinent criteria than those furnished by mere morphological observation. Morphological criteria are incomplete, too late of appearance, and actually deceptive through their failure to reveal basic constitutional differences among morphologically similar cells. If drugs, hormones, radiations, viruses, etc., after general application affect certain cells to the exclusion of others, this proves the existence of differential susceptibilities and selectivities in the responding cells for which we have as yet found no other measure than just that differential response to the agent. Pharmacology offers numerous examples of a given drug or hormone affecting one portion of the vascular system quite differently from another, or singling out one nerve center from others, or one type or area of connective tissue in contrast to another. These physiological distinctions constitute valid proof that the body contains a much greater variety of differentiations than can be discerned morphologically. The same conclusion must be drawn from the following facts. Different areas of epidermis in the fowl respond to stimuli from the same papilla by forming different types of feathers (Wang, 1943). Different parts of the vascular tree are intrinsically different in their characteristic growth patterns (Scharrer, 1940). Different parts of the epithelia of the reproductive tract respond differentially to hormones (Moore, 1944). Each muscle possesses a biochemical sign distinguishing it from all other non-homologous muscles (Weiss, 1936). All of these signify basic differences in the respective tissues which could not be discerned by microscopic inspection. The list could, of course, be greatly expanded.

The same reasoning applies to the developmental history of differentiation. The crucial test of differentiation is not different morphological appearance but differential behavior based on differential constitution. Eventually such behavior may lead to morphological distinctions, but if so, it precedes them. Therefore, all morphological distinctions are antedated by premorphological distinctions, the demonstration of which calls for discriminatory tests by other than morphological techniques. One such test is implicit in Waddington's (1932) concept of "competence." This term refers to the fact that cells change their response

patterns during development without expressing this change by convenient external signs. On the thesis that differences in response (under otherwise comparable conditions) must be based on differences of material constitution, deduced changes in "competence" may be regarded as a natural corollary and index of progressive premorphological differentiation.

PREMORPHOLOGICAL DIFFERENTIATION

Although the day seems still pretty far off when it will be possible to gauge and describe a given cell stage in terms of its actual properties, rather than indirectly by assaying developmental responses, certain hopeful approaches are opening up. One approach lies in tracing the developmental history of specific proteins that appear in the course of cellular differentiation. In first approximation, this can be done by determining the emergence of known proteins, such as myosin (Herrmann and Nicholas, 1948) or defined enzymes (Flexner, 1946, 1948; Boell, 1948; Holter, 1949). For purposes of differential diagnosis of cell differentiation, however, one would have to design much more refined cytochemical methods than are currently available. A more indirect way lies in the identification of proteins and protein differentials by their specific antibodies. Immune reactions to specific organ extracts can in many cases be demonstrated by the selective response of the homologous organs to the corresponding antibodies (Loeb, 1945; Landsteiner, 1946). Some years ago we started experiments to test the possible effect on embryonic organ growth of injected antibodies against the homologous organs (liver, kidney, and muscle in the chick). The results suggested the existence of a specific effect (Weiss, 1947), but they are in need of repetition and extension, and particularly the discriminative sharpness of the specificities involved remains to be demonstrated (Irwin, 1949). Research along similar lines has since been taken up by other laboratories (Pomerat, 1949; Grunwaldt, 1949).

We have continued the experiments recently in combination with radioactive tracers (jointly with D. H. Campbell). This was done by building a C_{14} chain into the organ-antibodies and then injecting the tagged material into the yolk of developing chick eggs. Any accumulation of the tagged material in the homologous organs would be evidence of selective absorption. Prior tets with C_{14}-tagged glycine injected into the yolk (jointly with J. W. Saunders and H. Holtzer) had shown ready accumulation of the active compounds in the embryonic tissues, and hence proved the feasibility of the method. Unfortunately, the tagged antibody preparations up to now have not had both a sufficiently high immune titer and a sufficiently high radioactivity to produce conclusive results.

By some such technique it might be possible to trace back organ specificity into its embryonic history and to reconstruct an "ontogenetic tree" of differentiations, much as phylogenetic relations have been established by serological tests (see Boyden, 1942).

Another technique of tracking down biochemical ontogeny lies in the application to the embryo of chemical agents with known organ- or tissue-specific effects in the adult. As a first test, we have injected xanthopterin into chick embryos, since this drug has been reported (Haddow) to have a selective stimulating effect on mitotic activity in the kidney of the adult mouse (in addition to general hematopoietic effects). The point was to investigate how early in development such an effect on the kidney or the kidney precursors in the embryo could be demonstrated (M. W. Cavanaugh, collaborating). Thus far, we have been able to show no other than toxic effects on the embryonic kidney, either when applied to the embryo itself or to embryonic tissue cultures containing xanthopterin (kindly supplied by Dr. Haddow, London). However, with the rapid growth of chemotherapeutical research, an infinite number of similar tests could be devised (e.g., possible effects of triazin on embryonic intestine), and work in this direction would seem well invested. Another lead worth investigating would be detection of incipient differences in embryonic tissues with respect to compounds that happen to be accessory growth factors for mutant strains of bacteria or fungi and, therefore, could be assayed by the addition of their extracts to deficient growth media.

For earlier stages of development, the splendid analysis of the differential action on different parts of the developing egg or embryo of specified chemicals, such as lithium, sulfocyanate, amino acids, etc. (Lehmann, 1945; Hörstadius, 1949; Ranzi, 1949; Lindahl, 1942), have brought us nearer an understanding of their mechanism of action. When properly evaluated, the results of this "chemical teratology" belong rightfully in the category of differentiation tests here advocated, since they not only expose, but actually identify, latent differences in protoplasm which are of developmental significance.

AFFINITIVE RELATIONS ("COAPTATION")

Although the physico-chemical detection of premorphological differentiation among cell strains

is thus still largely a matter of the future, one discriminative biological test is already at hand, and that is the capacity of the cells to tell each other apart according to their kinds. Thus we may use the cells themselves to do us a service which our analytical tools have not yet mastered. The model of this test lies in the classical experiments on dissociation and reassociation of coelenterates, hydroids, and sponges (see Brondsted, 1936). In those experiments, cells of a given kind were found to recombine with their own in preference to other kinds. The result is a self-sorting of cell types. The mechanism of selection does not seem to lie in specific attraction among homologous cells but rather in the fact that, upon making contact, matching combinations remain together while non-matching ones do not endure.

Similar affinities and disaffinities among cells of compatible or incompatible kinds have been described by Holtfreter (1939) in the early development of amphibians, the only difference being that in his cases cell groups rather than individual cells constituted the discriminative units. Cell groups which at an earlier stage are compatible gradually develop mutual incompatibility leading to segregation. This is clear evidence of a true biochemical divergence in the respective cell lines, hence of premorphological differentiation. In expanded form, this concept has, as I have tried to demonstrate (Weiss, 1947), fundamental implications for morphogenesis. It seems that cells, as a corollary of their differentiation, develop surface constitutions which render them adhesive to surfaces of the same or of fittingly complementary constitution, but unfit for association with non-conforming types. All during ontogeny cells and cell groups undergo extensive shifts, which bring about major changes of position, and hence, of mutual relations. During the resulting recombinations, permanent unions seem to be initiated by the active surface bonding of matching cell types, rather than by sheer mechanical cementing. In order to become settled, a cell must be fully adjusted and equilibrated with the conditions prevailing along its various surfaces, including its neighbors of the same kind, adjacent cell layers, the intercellular matrix, and the liquid media bathing its free portion. This relation may be designated as "coaptation."

Coaptive relations are outlined diagrammatically in Fig. 2. The top strip shows an epithelium whose cells A are adjusted to lateral association with similar cells A, to basal association with a cell type C, and to exposure to a medium B. The arrows at the right indicate compatible combinations in solid lines; incompatible ones in broken lines. The middle strip illustrates the unbalancing of the cell in consequence of a change of medium B to B′. The outer surfaces become unstable, and such cells may become motile. The same occurs when the lateral association among cells of the type A in a layer is severed so that a surface formerly bordering on A becomes exposed to a medium B. This is the case after injury, and it explains the automatic mobilization of the cells along the border of a wound, which is the primary response in wound healing. Evidently, any cells

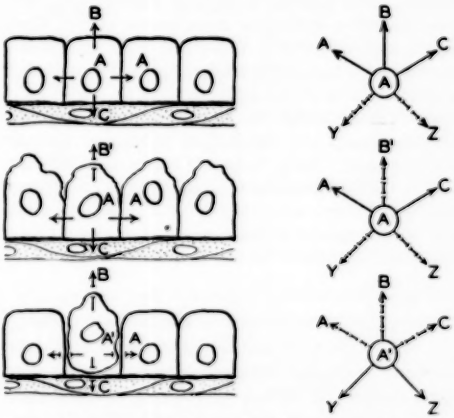

FIG. 2. AFFINITY RELATIONS IN EPITHELIUM (LEFT) WITH RELATION DIAGRAMS (RIGHT)

Full arrows indicate conformance of conditions (active "bonds"); interrupted arrows, non-conformance.

with unsaturated lateral "valencies" will keep on the move until they are completely surrounded by cells of their own or a related kind, when the condition of coaptive stability has again become satisfied. The mechanism that sets cells in motion at the beginning of wound healing and stops them again after its completion thus appears to be merely a special case of the more general principle of selectivity in cell association and dissociation.

The bottom strip of the diagram finally shows what may happen when one cell of a group becomes altered internally, for instance, as a result of somatic mutation. In changing from A to A′, it loses coaptation with all surrounding systems A, B, and C, and isolates itself or is expelled. As is indicated in the relations diagram on the right, loss of affinity to A, B, and C could conceivably

be accompanied by an increase in tolerance for less specific conditions Y and Z, which would allow the cell to survive under conditions under which it could formerly not have persisted. Formally, this depicts the behavior of cancer cells, particularly their estrangement from the mother tissue, invasiveness into other tissues, and capacity to become lodged in atypical locations. However, to fill this formal picture with factual content remains a task for the future.

The subtle means by which cells can recognize each other and their appropriate environments are still wholly conjectural. That their methods of identification are sharply discriminative can be demonstrated by bringing them together in atypical combinations. We have started a systematic investigation of this phenomenon (jointly with J. Chiakulas) by (a) interplanting fragments from various differentiated tissues of the amphibian larva in the gelatinous tail fin, which furnishes a vascularized, but otherwise rather neutral, testing ground; and (b) grafting patches of various epithelia (gut, cloaca, lung, etc.) into skin defects. Left to itself, a given tissue fragment (liver, pancreas, cartilage, kidney, etc.) readily fuses intimately with any other fragment of the same or of a related type, but retains a demarcation line against unrelated types.

I have tentatively suggested that the specific "recognition" may consist of the formation along the cell surfaces of specific stereochemical bonds between matching macromolecules in adjacent cells, comparable to the interlocking of antibody-antigen systems (Weiss, 1941, 1947). Whether the specific surface action is exercised by the outermost layer of the cytoplasm itself or by some film of specific exudate which no longer forms part of the living system, makes little difference in the present context. Yet, it is noteworthy that cells quite commonly exude macromolecular films which have important effects on cell behavior (Friedenwald, Buschke, and Crowell, 1945; Weiss, 1945), which have been suggested as intermediary binding agents between cells (Chambers, 1940; Schmitt, 1941), and which have been shown in protozoan cells to be the seat of serological reactions (Harrison and Fowler, 1946). The problem is somewhat complicated by the fact that the primary adhesive forces are secondarily reinforced and perhaps fully supplanted by intercellular fiber cements. Calcium seems to be an important factor in this process (Coman, 1944), but can obviously not account for the selectivity of the bonding.

It must be kept in mind that coaptation implies not only molecular surface conformance but also harmony with all mechanical and physiological manifestations of the surrounding cellular and non-cellular systems.

CONTACT REACTIONS

Once again, we are made to realize the necessity of revising the conventional concept of the cell in morphogenesis by giving the physical aspects of molecular behavior greater prominence. Those who accepted the cell as a relatively uniform elementary unit naturally came to regard chemical effects mainly in stoichiometric terms, that is, with the emphasis on composition, dosages, concentrations, and rates, but with little regard to spatial microorganization. However, as soon as the picture of the cellular unit is resolved into that of a highly organized population of interacting molecules and molecular aggregates, stereochemical properties, molecular structure, shape, orientation, alignment and, more generally, physical order, assume decisive significance in the determination of biological events. The concept of molecular ecology embodies this change of emphasis, for it illustrates how interfaces, by selectively adsorbing, orienting, and aligning molecular key species from the cellular content, produce the physical conditions of spatial order which enable stereochemically complementary compounds, such as antibody-antigen or enzyme-substrate systems, to interact most effectively. According to this concept, the following would happen when a cell comes into contact with another body whose surface is settled with molecules with specifically formed end groups oriented toward the oncoming cell. As the agitated molecular population of the moving cell passes in review, as it were, before the stable molecular front of the outer surface, molecules of conforming configuration will be trapped by their correspondingly shaped counterparts. Thus, a specific fraction of the cell content will gradually become concentrated and segregated along the contact surface. Since these surface molecules, by virtue of their orientation, might serve not only as anchor points for the adsorption of additional molecules from the interior, but also perhaps as specific catalysts of reactions inside the cell, a whole train of events determining the further chemical history of the cell has thus been set into motion. It can readily be seen that the chemical fate of a cell on contact with another does not depend merely on what substances are present in it, but also on the strategic advantages given to one or another

segment of the molecular population according to the chemical character of the contact surface.

This condition is illustrated diagrammatically in Fig. 3, which shows two epithelial cells in three consecutive stages. Large molecules with specific end groups are indicated by various symbols. In the initial stage, both the upper and lower cells have identical chemical endowments (lefthand diagrams). Now let us assume that the upper cell makes contact with a system containing in its surface oriented molecules with arrow-shaped heads, while the lower cell confronts a surface chains of chemical reactions are thus set going in the two cells, it will not be long until the composition of their contents will have become radically different; each will develop certain compounds not present in the other. The eventual consolidation (righthand diagram) is irreversible and represents what we have called cellular differentiation, while the transition stage (middle diagrams) is still reversible, representing mere modulation. Permanent differentiation can, therefore, be regarded as merely an advanced stage of an initially reversible modulation.

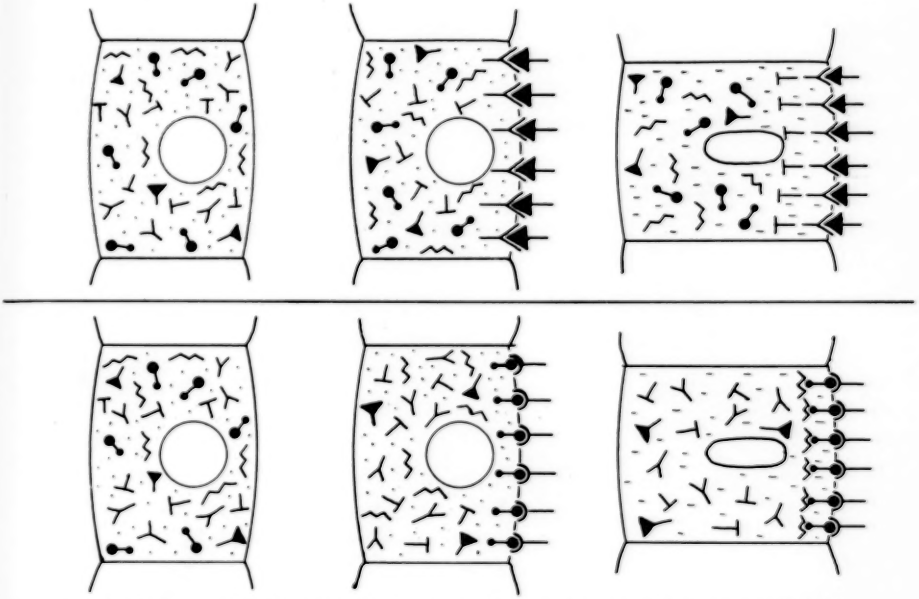

FIG. 3. MOLECULAR REARRANGEMENTS UPON CONTACT WITH DIFFERENT ORGANIC SURFACES: A MODEL OF INDUCTION

with molecules with cup-shaped ends (middle diagrams). As a result, in the upper cell, the notch-shaped molecules will be trapped and fixed, and in the lower one, the ball-shaped ones,—in either case, those of the most nearly conforming configuration. As one can see, the chemical composition of the two cells is still the same, but a segregation process has been initiated which is different in the two and, if allowed to continue, will in consequence lead to an increasing internal diversification. This is indicated in the righthand diagrams, in which each cell is shown to have added a second macromolecular layer of fitting configuration to the first. As entirely different

Since my presentation of this concept of the molecular basis of differentiation at the Growth Symposium in 1945 (Weiss, 1947) and again at the Princeton Bicentennial Conference in 1947 (Weiss, 1949a), Spiegelmann (1948) has set forth some thoughts that, although making no explicit reference to our views, implement them in several points.

INDUCTION

It will be immediately recognized that the above diagram gives a pertinent illustration of those specific influences of one tissue on an adjacent one, commonly referred to as "inductions." The most frequently cited examples are the effect of the chorda-mesoderm upon the overlying ectoderm in

calling forth the formation of a neural plate, and the induction of lens in the epidermis overlying the eye vesicle (Spemann, 1938). It has long been known that under natural conditions such inductions take place only if the inducing and induced layers are in close contact. Interposition of a narrow gap or a thin layer of some other tissue abolishes the effect (Dragomirow, 1929; Holtfreter, 1933). However, no systematic study has been accorded this subject. In observations on the finer histological changes attending lens induction in the chick, I noticed some years ago that at the time of contact between the eye vesicle and the ectoderm, the cells of the latter become elongated and oriented in the direction of the subjacent retinal cells (see Weiss, 1949b, p. 478). Their nuclei assume a rod shape and move to the border of contact (Fig. 4). These changes are now being studied more closely (in collaboration with M. McKeehan). The phenomenon of orientation seems to be exactly coextensive with the area of intimate contact. It lasts only for the few hours known to be the crucial and critical time for lens induction (Fig. 5). At the same time, the cells of the lens ectoderm become so firmly fused to those of the retina within the contact area that the two layers cannot be separated (also observed casually by Stone and Dinnean, 1940). Thus, we have evidence that the contact produces an intimate association between the two cell types followed by an oriented reorganization of the presumptive lens plate in relation to the more advanced and consolidated retinal plate—just the type of changes to be expected in terms of the above concept. Having gone through this critical surface reorganization, the induced layer becomes detached and can then continue independently with the next step in the formation of a lens vesicle. If it had been faced with another tissue than eye cup, some other segment of the molecular population would have been segregated in the surface, yielding another type of differentiation, always within the limitations of the molecular equipment ("competence") available in the cell at that particular time.

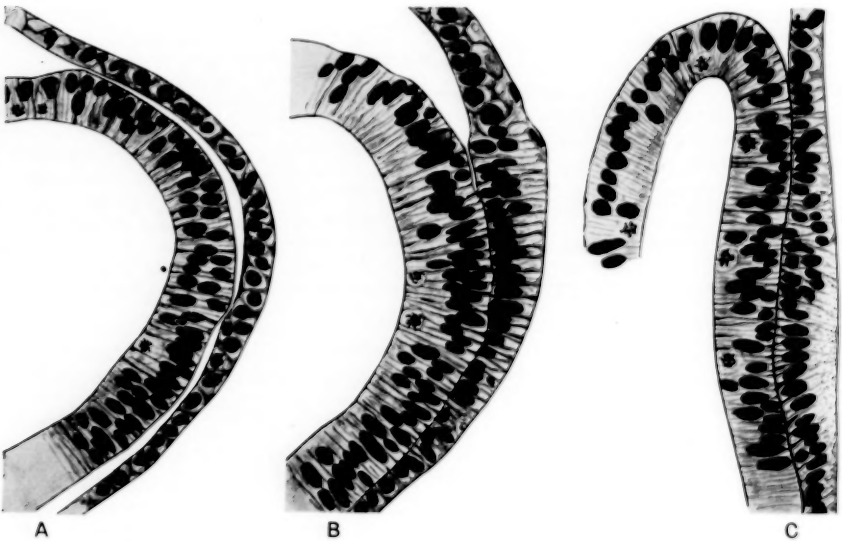

FIG. 4. CELLULAR CHANGES DURING LENS INDUCTION

A, Preinduction stage (ca. 14 somites): contact between retina and epidermis about to be effected; epidermal cells unoriented. B, Height of induction stage (19 somites): cells within contact area oriented towards retina; nuclei near basal pole. C, Postinduction stage (21 somites): early self-differentiation phase, with beginning concavity of lens placode and concomitant reorientation of lens cells radially.

Cell elongation and nuclear orientation are regarded here as due to an oriented reorganization of cell components in the direction of the contact surface rather than to an increased lateral attraction between neighboring cells, which has been suggested as the mechanism of neurulation by Brown, Hamburger, and Schmitt (1941). The

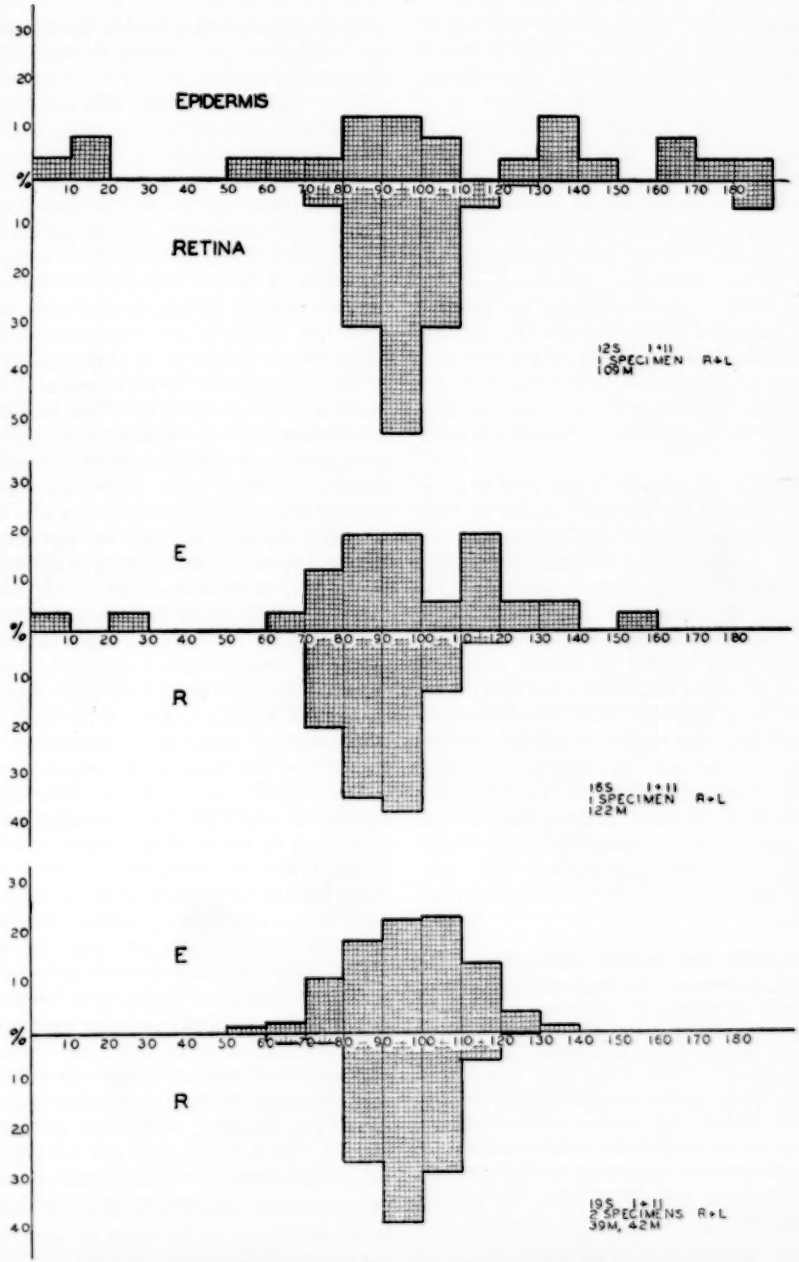

FIG. 5. STATISTICAL EVIDENCE OF ORIENTATION EFFECT ILLUSTRATED IN FIG. 4

The axes of the cell nuclei in retina and overlying epidermis were traced. The angles between these axes and the retinal surface were measured. The percentage frequencies of the various positions (in classes of 10°) were then plotted, downward for retina, upward for epidermis. Peak frequencies at 90° indicate perpendicular orientation. Top: 12-somite stage. Middle: 16 somites. Bottom: 19 somites. The progressive orientation of the epidermis relative to the retina from top to bottom is evident. (From unpublished data of M. McKeehan.)

correlation between diffusion lines and microstructure observed by Pollister (1941) in mature cells gives indirect support to our interpretation. Marked orientation of cells ("palisading") as an early symptom of induction has been reported incidentally by several authors without further comment (e.g., Lehmann, 1929; Holtfreter, 1933). It is common in many pathological transformations (e.g., tumors), and we have also observed it in the skins of amphibian larvae over topically applied crystals of the carcinogen, methylcholanthrene (Overton, 1948). A closer cytological and physicochemical analysis of the phenomenon of palisading, with particular attention to such signs of molecular regrouping as stratification, orientation of fibrous elements, etc., therefore promises to yield valuable clues as to the mechanism of inductive contact interaction.

According to the hypothesis here proposed, the inductive effect of one cell upon another and the selective adhesion (contact affinity) between two cells would have a common denominator, namely, the formation of linkages between matching molecules across the contiguous cell surfaces. Each patch of interlocked key molecules along the interface would then become an anchor point for bundles of molecular chains extending into the interior of both adjoining cells. Morphologically this would look like fibrillar continuity. On the molecular level, however, this would merely mean continuity of axial orientation among the chains on either side of the interface. This is a good example of how many of the microscopic arguments about contiguity vs. continuity among cells (e.g., neurons) lose their meaning when viewed in molecular dimensions.

Porter (1948) has recently produced electron-microscopic pictures of contiguous epithelial cells in which fibrillar strands can be seen to pass continuously from one to the other across the border. Although strains and stresses during histological fixation may have exaggerated it, the picture does suggest that orientation effects can be transmitted from one cell to another without the presence of "protoplasmic continuity" in the sense of the classical microscopist (see also the inductive transcellular orientation effects observed in plants [e.g., Sinnott and Bloch, 1945; Gautheret, 1946]).

ASSIMILATIVE INDUCTIONS

One of the features complicating the study of embryonic induction is the fact that the response of induced tissue consists mostly of a complex chain of reactions which involves further inductive and segregative acts. Much clarification may, therefore, be expected from a study of more elementary and more uniform induction processes such as take place during later stages of development, particularly within a given tissue, as for instance, the induction of cartilage by cartilage. Nageotte (1922) was the first to show that even alcohol-fixed cartilage can still induce the formation of additional cartilaginous tissue in the ear of the rabbit. A further utilization of this method promises to reveal, at least for these cases, to what extent the specificity of an induction product is determined by the specificity of an inducing tissue on the one hand, and by the character of the responding cells on the other. This problem has received considerable clarification by the use of heteroplastic and non-living grafts as "inductors" (literature in Weiss, 1935), yet it would seem even easier of solution if simpler conditions were chosen. We have, therefore, extended the experiments of Nageotte on the inductive action of differentiated tissues after devitalization. Rapid deep freezing, followed by dehydration in vacuo at low temperature, has proved to conserve many properties of the living tissue (including enzyme activity and physical structure) more truly than most other methods of fixation (Hoerr, 1943; Boell, 1945). When cartilage treated in this manner was transplanted into the limbs of salamander larvae, it became partially resorbed, but the defect was then repaired by host cells which deposited new cartilage along the surface of the devitalized fragment (Weiss, 1944b; see 1949a, Pl. 2, p. 151), as bees would build on to an artificial honey comb. Similarly, frozen-dried cornea grafted into corneal defects in the eyes of rats and rabbits was seen to induce the formation of new corneal layers in the host tissue (Weiss and Taylor, 1944; Leopold and Adler, 1947). Evidently, specific effects of the grafts have stimulated the host tissues to homologous formations. Further experiments will have to decide whether or not this involves more than simply the activation of latent homologous cell reserves. The fact that dead graft and live host tissues have formed an organic union distinguishes these cases from induction by dead tissue obtained in the embryo, as in the latter the dead piece is not structurally adopted by the host.

There have been some interesting reports on bone induction in developed animals by alcohol-extracts of tissues (Levander, 1945; Bertelsen,

1944), but the specificity of these effects has been rightly questioned (Heinen, Dabbs, and Mason, 1949) and their interpretation is still in doubt.

The facts and ideas about induction presented above clearly militate against the opinion often expressed in current literature that induction is carried out by diffusing chemicals discharged from the inducing tissue, implying that physical conditions are of no particular relevance to the effect and, therefore, may be ignored. So long as the precise mode of operation of this class of inductions has not been identified, mere reference to the participation of "chemical agents" remains a platitude, and insistence on the diffusibility and stoichiometric character of their effects a gratuitous presumption. Even those inductions which have been obtained after immersion of a tissue into a supposedly structureless liquid might turn out to be mediated through a structured physical envelope of coagulated macromolecular matter liberated from damaged cells. Observations on the relation between cytolysis and induction (Holtfreter, 1948a) encourage such a view. Additional work is needed, however, to make the proof conclusive. In support of diffusible action, cases have been reported in which embryonic inductions evoked by organ extracts differed in character depending on the evoking agents (kidney or liver) (Toivonen, 1940). But this could also be explained in terms of differences in the reacting tissues. If, for instance, the rates of liberation, penetration, etc., of these two substances were different, such that one would affect the embryo at an earlier stage than the other, the responding cells, being in different stages of "competence," would naturally turn out different products (see also Holtfreter, 1934).

Moreover, in all such considerations, one must never lose sight of the fact that since in the past quite a variety of phenomena have been arbitrarily labeled as "inductions," it would be unreasonable to expect them to be all of a single kind, to have the same basic mechanism, or even to follow a common rule. We must be prepared to find "inductions" of many degrees of specificity and complexity, employing a great variety of mechanisms, in which physical factors and chemical agents participate in many sorts of combinations.

PROTOPLASMIC REPRODUCTION

We have treated differentiation primarily under one aspect, namely, the appearance of differentials among cells that were originally alike. There remains another aspect to be considered, namely, the perpetuation of the differentiated state as a cell grows and reproduces. Differentiation is actually a property of the cell strain. An individual cell is but a sample taken from the protoplasmic time continuum of cell generations that lead from a blastomere to the mature stage. As it matures, this mass gradually evolves the inner diversity which we call differentiation. By successive cell divisions, the progressively transforming mass is subdivided, but the differentiated constitution—though not every differentiation product—is carried over directly from mother cell to daughter cells. Thus, no cell past the germ cell stage is ever in a strictly "undifferentiated" state.

Let us now assume for the moment that we had a complete molecular inventory of each cell, listing all the chemical compounds to be found in it, their relative concentrations, distributions, and arrangements in space. Let us then consider two cells of the same germ which have undergone some degree of differentiation, in divergent directions, and hence differ in their molecular populations; for example, a myoblast and a neuroblast (Fig. 1). Although descended from equipotential stock, these two cells are no longer equipotential. One can no longer be turned into the course of the other. Each propagates only its own kind, and in doing so, imparts its own specific character to its offspring. The lessons of tissue culture have demonstrated that the basic character of a cell acquired during ontogeny is faithfully reissued in all its progeny (see Bloom, 1937; Thomas, 1938). If this were merely a matter of a given store of equipment being distributed over the descendants, one would have to expect a progressive dilution or attenuation of the differentiated character in successive cell generations. Differentiated products, if not renewed, may suffer this fate (e.g., yolk platelets in the course of successive divisions of primordial blood cells; Cameron, 1941); but the basic differentiated protoplasm has never shown any sign of depletion so long as growth and proliferation continue. We must conclude, therefore, that as a daughter cell grows up to the size of its mother cell, it reproduces and multiplies the specific molecular population of the latter in essentially the same form in which it received it. Myoblasts reproduce myoplasm, and neuroblasts neuroplasm.

This raises a very interesting problem. Accord-

ing to current genetic opinion the chromosomal genome remains qualitatively the same for all cells throughout development (for some qualifications, see Huskins, 1947). All differentiated cell strains, therefore, are supposed to possess the same genome. Nevertheless, as just outlined, they breed true according to kind, not unlike so many different strains of protozoans. Are the two facts at variance?

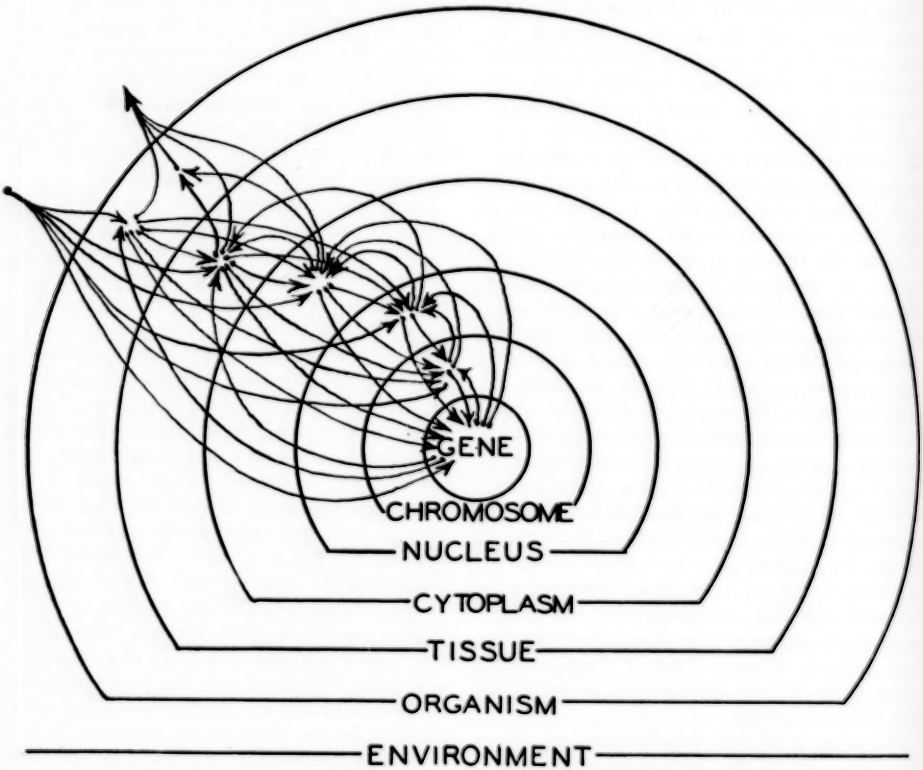

FIG. 6. RELATIONS DIAGRAM FOR HIERARCHICAL ORGANIZATION OF THE BODY

In dealing with the relations between genetics and development, it is well to keep in mind that an organism is constituted like a system of Chinese boxes, in which larger ones enclose smaller ones in a descending series of magnitudes. This hierarchy of systems is indicated in Fig. 6. This diagram shows the gene as part of the chromosome, the chromosome as part of the nucleus, the nucleus enclosed in the cytoplasm, the cell as a whole enclosed in the tissue, and the latter again enclosed in the organism, which in turn is set off against the environment. Theoretically, any one of these systems can be affected only through the medium of the systems of the next higher and next lower orders. Each layer of the diagram, therefore, is potentially a filter and transformer for actions and agents that penetrate it. Some, like radiations, may pass through relatively unaltered, while others may be profoundly changed in transit. A chemical entering from the environment may react, hence be altered, in passing through the surface of the organism, again in the tissue juices, once more in the cytoplasm, again in passing through the nuclear space, and finally in the non-genic chromosome matrix, before it ever reaches a gene. Furthermore, as each one of the series of shells of this diagram must be viewed as a potential originator, as well as receiver, of actions relative to any and all of the other shells, we are confronted with a very complex

system of possible interactions, the intricacy of which is symbolized by the confusion of lines in the diagram. To bear this situation in mind will keep us on guard against oversimplified concepts regarding the directness of effects of "gene substances" on peripheral characters, and conversely, of peripherally applied substances upon genes.

Growth means the augmentation of protoplasm. Since this can occur only in the presence of an original protoplasmic model, we correctly speak of reproduction, rather than production. We know that the growth of the organism and of its tissues can take place only through the agency of its cells. Therefore, the mechanism of growth, as protoplasmic reproduction, must lie somewhere within the inner circles of our diagram. In order to reconcile the identity of the genic equipment (innermost circle) of all body cells with the specific self-reproduction of the various differentiated protoplasms, one has come to assume "self-reproducing" or "self-duplicating" units in the cytoplasm, which for obvious, though not necessarily valid, reasons are called plasmagenes. Combined evidence of morphological, physiological, biochemical, and genetic character, summarized in recent symposia (Sonneborn, 1947; Lwoff, 1949; Brachet, 1949) has made an impressive case for the existence of such self-reproducing cytoplasmic particles. Their potential significance for the problem of differentiation has also been properly recognized.

Yet, to charge the perpetuation of differentiation wholly to identifiable autonomous entities, set in opposition to an undifferentiated matrix, would seem to oversimplify the issue. Moreover, while it is conceivable that differentiation, like genic transmission, resides in discrete particles, we cannot be sure that the synthesis of the specific macromolecular compounds which make up these cytoplasmic particles actually takes place in the locations at which we find them, as is implied in the term "self-duplication." If this were true, growth would occur in innumerable small centers scattered throughout the cytoplasm. That this is not the case has been shown by some recent studies on the growth of the neurone.

In an extensive series of experiments, we have found that the enormously elongated cytoplasm of the axis cylinder does not contain its own sources of growth but that all growth comes solely from the nucleated territory in the central cell body (Weiss and Hiscoe, 1948). When the cross section of an axon is locally reduced by constriction the part lying distal to the bottleneck, that is, on the far side relative to the cell body containing the nucleus, remains undersized in proportion to the amount of constriction, while excess neuroplasm piles up at the proximal side of the narrow passage. In general terms, this bears out the contention of Caspersson and his school (see Hydén, 1943), according to which all specific protein synthesis takes place at the site of the nucleus. It goes beyond these views, however, in indicating that the nuclear products are already the real stuff of growth rather than merely catalytic agents which would then secondarily initiate and entertain local growth in the distant cytoplasm. Our results suggest that all protoplasmic systems that ever occur in the space of the cell must have been delivered originally from the nuclear space. On this basis, all protein systems and other complex protoplasmic systems found in the cytoplasm that are different from the primordial nuclear source products would have become so by processes of degradation and conversion from the primordial source products. In this light, the existence in the cytoplasm of sites of true protoplasmic synthesis becomes questionable, and one would have to turn to the following alternative view.

The basic protoplasmic units would be reproduced within the nuclear space in a complex primordial form determined by the whole genic apparatus. They would be alike for all cells of a given individual of a given species. On their course from the producing source into the cytoplasm, they would be subject to conversions and modifications. Especially, upon impact with certain specifically shaped template systems, they would assume conforming shapes and thus perpetuate particular molecular patterns. Since, as we tried to illustrate before, each cell strain in the course of its differentiation develops its own specific population of template molecules, the same primordial genic products will assume different shapes and properties depending on the particular molecular populations with which they make contact in the nuclear and cytoplasmic spaces. According to this concept, differentiated protoplasmic units would owe their origin and their specific shapes to two entirely different processes, occurring in different places. They would be propagated in the nuclear center, and be remodeled in the cytoplasm. These two phases might very well correspond to the two phases in protein synthesis (replication and folding) suggested by Haurowitz (1949). To use a crude simile, it would be somewhat like the mak-

ing of furniture. The wood is grown by the forest but shaped by the carpenter. Neither does the carpenter grow wood nor does the forest shape benches. If this concept is correct, then what have appeared to be self-reproducing bodies in the cytoplasm would simply become model centers of adsorption, aggregation, alignment, and conversion of compounds which have originated in a distant location. We would have to call them "self-perpetuating," but not "self-reproducing," systems, as they would perpetuate their own pattern, template fashion, but not actually produce more of their own substance.

It is apparent from this discussion that on the strength of biological considerations, a sharp distinction is indicated between the continuous regeneration of existing protein molecules and the reproduction of new ones. Although tracer techniques have definitely established the fact that protein molecules are constantly exchanging fragments with corresponding fragments from the medium, thus preserving their statistical integrity (see Schoenheimer, 1942), there is absolutely no evidence as yet that fragments can ever be pieced together to form a whole protein molecule unless there is already a whole molecule present to serve as model. Thus, even on biochemical grounds, it would seem legitimate to distinguish sharply between the multiplication of protein systems (growth) and their mere maintenance and restitution, with or without concurrent changes of configuration (remodeling; differentiation).

Whether the dualistic concept of growth and differentiation proposed in this chapter can be substantiated by further research remains to be seen. Pending proof to the contrary, it deserves serious consideration as a possible alternative to the thesis of self-reproducing bodies in the cytoplasm which are supposed to be at the same time gene-dependent and autonomous. It is intriguing to compare our concept of the differentiation of cell strains, as here related, with the induction, transmission, and perpetuation of cytoplasmic varieties in protozoans with a common genome (Sonneborn, 1947). The parallelism seems to be more than superficial.

If growth is the result of nuclear synthesis followed by molecular conversion in interaction with cellular templates, growth rate will evidently depend on both the rate of synthesis and the effective concentration of templates. If the template conversion process is of the antigen-antibody type, antibodies against organ proteins might, by serving directly as templates, have an effect on growth rates. In 1939a, I reported preliminary results (with D. H. Campbell) indicating such a possibility, and in 1945 I suggested a generalized hypothesis of growth catalysis by complementary template systems comparable to antigen-antibody relations (Weiss, 1947). Tyler (1947) has advocated a similar "auto-antibody" concept of growth based on his extensive studies on complementariness in fertilization. However, neither the homology nor analogy of our hypothetical cytoplasmic templates with antibodies has actually been proved. Perhaps the demonstrated effect of specific antibodies on hereditary cytoplasmic transformations in *Paramecium* (Sonneborn, 1948) has a direct bearing on this problem.

GROWTH AND PATTERN

Tissues form as a result of association or non-dissociation of cells of the same kind, of the combination of cells of complementary types, and of the addition and interspersing of intercellular materials, which in turn are cell products. In the last analysis, therefore, histodifferentiation is the outcome of cytodifferentiation. As cells form increasing larger compound groups with an increasing complexity of interactions, they thereby set up novel conditions resulting from their group relations, to which the individual members of the collective now become subjected differentially, depending on their locations within the group. These emergent "field" conditions then become determining, or at least limiting, factors in the further course of growth and differentiation. One of the most striking examples in this class is the gradual confinement of proliferative activity in a tissue or organ to a circumscribed area (germinal cord or germinal layer: e.g., inner surface of the neural tube; rim of the optic cup; equatorial region of the lens; basal layer of the epidermis). In most of these cases, the proliferating area is characterized by some geometric peculiarity: the edge of a fold, the tip of a bud, the border between two tissues or between a tissue and fluid bathing it. These geometric positions obviously represent unique physico-chemical conditions of exposure which are not shared by other parts of the tissue. Cells removing themselves or being passively separated from those unique conditions, therefore, are automatically eliminated from further proliferative activity and usually continue in their differentiative course toward terminal stages (see Weiss, 1939). Plain as this correlation between geometric configuration and developmental fate is, we are still altogether ignorant of the mechanism by which it operates. We do not know what stops growth and mitosis in one part of a tissue,

what maintains growth without mitosis in another (as for example in the steadily growing neuron), and what permits the germinal areas to go ahead with both growth and mitotic activity. For instance, does the cerebro-spinal fluid of the embryo contain a principle which supports mitotic activity in the adjoining neural epithelium, or does the mantle contain factors which suppress it? We do not know.

Detwiler (1947) and Harrison (1947) noted that in the process of regeneration of an extirpated lateral half of cord or brain from the remaining half, the regenerate showed numerous extraependymal mitoses. This observation might furnish a clue to further analysis, since the appearance of mitotic cells in the mantle could perhaps be related to the penetration of cerebrospinal fluid into the cell mass as a result of the operative disruption of the inner limiting membrane. In general, our knowledge of the causes underlying the appearance, subsidence, and focal localization of mitotic fields is extremely poor.

We are not much better off with regard to growth patterns in general. In a few selected cases we understand the basis of differential growth, at least in principle (see Weiss, 1949a), but for the most part even the mere biomechanics of the formation of tubes, folds, evaginations, ramifications, and so forth, are not much better understood than in the days of His and Hertwig, when they were first clearly formulated as problems. One thing we have come to realize is the great complexity of morphogenesis. What passes for differential growth is by no means merely a matter of differential proliferation, but is a mixture of cell movements, shifts of cell layers, aggregations, combinations, and separations, in addition to true proliferation; there is stretching and shrinkage, thinning and thickening, tearing and shedding, deposition and resorption. These are prime factors of morphogenesis. Growth thus does not really lay down morphogenetic patterns, but rather follows and elaborates them. In other words, it has become ever clearer that growth, as such, is a purely scalar process, producing simply more protoplasmic mass, increments without intrinsic direction. Direction is given to the growing mass not by properties inherent in the chemical mechanism of reproduction itself, but is imposed by physical properties of the space into which the material issues forth. Physical factors of given polarity, such as tensions, pressures, electric gradients, diffusion currents, fibrous pathways, and the like, appear among the factors that guide the deposition and extension of the growing material along preferential lines and channels. Growth has no sense of direction, and all directive growth owes its orientation to factors outside the loci of protoplasmic production. Some cells create their own physical frame to guide the growth of their protoplasm, as for instance, the heliozoa, whose arms are protruded by a crystalline axial skeleton, or the plant cells, whose cellulose wall determines by its longitudinal stretching the direction of cell division, and hence the polar growth of the cell column. In animal germs, the presence of a coherent fibrous surface coat presumably acts in a similar capacity. Since it weaves the cells into a common fabric, any systematic distortion of its meshes, as for instance, by the local contraction at the blastopore in the act of gastrulation (Lewis, 1947; Holtfreter, 1948a), introduces certain directive vectors into the movements, extensions, cell divisions, and internal rearrangements of the adherent cell sheets, and thereby sets a pattern for subsequent growth (see also Devillers, 1948; Trinkaus, 1949). The mobile cells of later developmental stages find similar physical guides in the protein network pervading the interstices of the body, and a major part of the phenomena of oriented growth can be explained by this principle of contact guidance (Weiss, 1941; 1948). At the same time, chemical factors contribute to growth patterns in a variety of ways, by modifying the structure of physical pathway systems (Weiss, 1934; 1949a), by establishing selective affinities between certain cells and certain pathways (Weiss, 1941; 1947), by promoting or inhibiting cell division (Lehmann, 1945), and generally, by taking part in all the component activities of morphogenesis listed above.

Consideration of this complexity renders senseless any attempt to classify effects on growth simply as "growth stimulation" or "growth inhibition." For example, the following are merely a few of the possible causes of "growth inhibition": lack of essential building blocks for protoplasmic synthesis, interference with the intake of essential compounds, lack of proper physical conditions for their assimilation, inadequate metabolic energy resources, space restrictions, active obstruction by neighboring units, blocking of the mitotic apparatus, etc., where each one of these contingencies may itself arise from a variety of causes. Anything then that partially or totally offsets any of these

inhibitory actions would thereby automatically rate as a "growth stimulant."

The complexity of the process of growth should also discourage the continuation of those purely formal attempts to deal with it as if it were a simple entity (e.g., a "bi-molecular reaction"). It likewise minimizes the analytical value of growth curves for complex organisms. At the same time, growth curves have revealed over-all regularities which analytical preoccupation with the cellular mechanism of growth would hardly have disclosed. This goes for such phenomena as allometric growth, compensatory hypertrophy, effects of age on growth, and the like. Such observations bring us face to face with certain regulatory actions within the organismic system as a whole which have thus far proved most refractory to analytical investigation. References to homoeostatic maintenance of chemical balances, hormonal equilibria, competition for nutrient substrates (Spiegelmann, 1945) (which is merely a modern expression for Roux' classical "struggle among parts" or Robb's "partition coefficients"), metabolic gradients (Child, 1941), electric fields (Burr and Northrop, 1935), etc., are pertinent in illuminating each a particular facet of the problem. However, the fact that they all, in spite of their great diversity, seem to obey a common regulatory principle has never been explained in any but purely descriptive or evasive terms.

MORPHOGENETIC FIELDS

This brings up what is perhaps the most difficult and the most neglected of all basic problems in morphogenesis, that of super-cellular integration. Although behaving as individual units in their reactions, cells, when in a group, act as collectives. Such collectives exhibit properties and powers of "gestalt" character which are not recognizable in the isolated elements. One of the primary differences in a group is that of position. Secondarily, differences of position and exposure lead to differentials of activity and reaction. A simple and trivial example is the differential between center and margin. Any activity or property that varies systematically between center and margin of a given mass of active material will affect different members of the group differentially, depending on their coordinates in the system as a whole. The importance of the principle of patterned "field" activities in the determination of embryonic events has been generally recognized, and they have been given currency under such names as morphogenetic fields (Weiss, 1935; 1939a) or gradient systems (Huxley and de Beer, 1934). Yet their nature and mode of operation are still among the greatest puzzles of modern biology (see Sinnott, 1940).

If we were simply dealing either with differences in concentrations of substances arising from differential accessibility to food pools or accumulation of metabolites, or with electric gradients or with tension fields, or with any other single, uniform class of phenomena subject to a merely quantitative gradation along a linear scale of values, field activities could be understood, at least in principle, on the basis of existing concepts. A more penetrating appraisal shows, however, that no field concept operating with only a single variable can adequately represent the facts. After all, one has to explain that a determinative field vector causes not just a quantitative change in the activity of a responding cell, but selectively activates in the latter a specific performance from among a whole series of equally possible ones, perhaps by specific molecular segregations, as indicated earlier. This, it would seem, makes it imperative to concede to the field vectors the property of affecting molecular configuration and constellation, rather than only concentrations and reaction rates, with which a merely "quantitative" field theory would be concerned. It may become necessary to assume that at any given point of a particular field, conditions of such specific constellation arise that certain molecular groupings will be selectively favored or energized by a sort of resonance relation between field and molecular pattern. This is evidently a domain into which as yet no empirical road has been found. An identification of morphogenetic fields with electrostatic fields (Burr and Northrop, 1935) is undoubtedly simpler, but it cannot even remotely account for the subtlety of the relations which we are to explain. Granting the existence of electric fields, of metabolic gradients, and of other graded properties, and acknowledging differences of threshold among different cells for different combinations of these agents, this still leaves the structural order and systematic, qualitative variation of the field vectors in the different directions of space in a conceptual vacuum.

However, there is no cause for discouragement. There is merely cause for caution against premature generalization. Because of the forbidding difficulty of the field problem, the experimental procurement of more pertinent facts has lagged

badly. It seems that more such information is needed before we can go on speculating. In this penetration into the unknown, we had better not tie ourselves too closely to the current predilection for diffusible chemical agents, but rather explore the possibility that field effects might be propagated by transmission rather than convection. That is to say, control over large cellular collectives may spread not by substances being bodily transported from cell to cell, but by states of molecular activities being relayed from one molecular system to the next (see also Wigglesworth, 1948).

The primary integrative actions of embryonic fields are in later development superseded by the various chemical coordination systems of the body, which are somewhat better understood. But even though we know the chemical composition and the general mode of action of many hormones, we are still far from understanding the selectivity of their terminal effects and the over-all harmony of their interactions.

CONCLUSIONS

I have sampled here some of the main current problems of morphogenesis. I have made it a point to illustrate the inadequacy of their present state, not in a spirit of defeatism, but on the contrary to emphasize the rich prizes the future holds in yielding solutions to those problems. I have indicated a few promising ways leading into the future, drawing disproportionately on examples from my own experience, not because I believe these ways to be more meritorious or rewarding than others, but simply to demonstrate that there are practicable ways, and to be concrete and convincing in this demonstration. The future of the field of morphogenesis will, of course, be what the workers in morphogenesis make it. The reawakened interest in its problems, the conjoint attack by formerly separated disciplines, the introduction of novel analytical tools, the growing conceptual precision, all these signs augur well that its future will be bright.

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NEW BIOLOGICAL BOOKS

The aim of this department is to give the reader brief indications of the character, the content, and the value of new books in the various fields of Biology. In addition there will occasionally appear one longer critical review of a book of special significance. Authors and publishers of biological books should bear in mind that THE QUARTERLY REVIEW OF BIOLOGY *can notice in this department only such books as come to the office of the editor. The absence of a book, therefore, from the following and subsequent lists only means that we have not received it. All material for notice in this department should be addressed to H. B. Glass, Associate Editor of* THE QUARTERLY REVIEW OF BIOLOGY, *Department of Biology, The Johns Hopkins University, Baltimore 18, Maryland, U. S. A.*

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GENERAL BIOLOGY: PHILOSOPHY AND EDUCATION

THE WORLD OF LIFE. *A General Biology.* *By Wolfgang F. Pauli; edited by Bentley Glass. Houghton Mifflin Company, Boston, New York, Chicago, Dallas, Atlanta, and San Francisco.* $5.00. x + 653 pp.; ill. 1949.

A casual glance at Pauli's text will show the reader at once that here is a unique general biology, even if only the selection of illustrations is considered. These are very numerous, attractively printed, and reflect a great ability on the part of the author, illustrator, and printer in working with original and clear illustrative media. The reviewer, in fact, has seen very few textbooks of any description that equal Pauli's in this respect.

A more than casual investigation of the subject matter of the book reveals that its approach to the study of biology is as unique as its illustrations, for the author has used the principle of evolution as his basic organizational theme. In developing this, he opens with a discussion of the nature of the universe itself and the behavior and structure of inanimate matter. This is followed by considerations of the general properties of cells that in turn lead to a presentation of evolutionary evidence and principles, including a brief survey of the paleontological record.

Sections on the rise of plants and animals follow, with the vertebrates receiving additional attention in a subsequent section. Finally the text closes with two chapters on genetics and eugenics, respectively. Two appendixes are included, one on the classification of plants and animals, the other on biological terms.

Generally, in these various sections, Pauli has written with a view toward topical completeness that of necessity prevents detailed discussion of any one topic. His style is lucid, and he avoids both the superfluity of biological terms too often found in biology textbooks and the omission of essential vocabulary.

The reviewer considers the inclusion of chapter material on the inanimate universe a most excellent idea that Pauli has carried out with great skill. Similarly, the organization of the book around the central theme of evolution has much to commend it, although it is apparent that opinions will differ as to what the most logical order for the development of this theme should be. It is to be noted in this regard, however, that this textbook should be useful regardless of the order in which its various chapters are considered.

In fact, rather than the order of presentation the teacher should consider the point that so much material is covered in the book that selection might have to be made in courses with restrictive schedules. This does not mean that the textbook will not prove to be

successful in courses that are unable to consider all its contents. Rather, it should provide a strong background against which to teach biology, even though it may require some guidance of the student to prevent his becoming lost in the wealth of information presented.

The book would be strengthened by a presentation and discussion of the simpler mathematical formulations that are the basis of modern views on the study of population genetics and evolution. In addition, the reviewer would like to note that the opinions expressed on eugenics are not entirely shared by students of human genetics and suggest that the teacher not familiar with this material ought to refer to other discussions as well as those of Pauli.

The only error in printing detected by the reviewer was a minor one in the labeling of the figure on page 546. In closing it may be said that the publisher has done a superb job of presenting a book that should receive careful attention from all biologists interested in keeping their courses "alive and moving."

JOHN CUSHING

TELEOLOGICAL MECHANISMS. *Annals of The New York Academy of Sciences. Volume 50, Article 4.*

By L. K. Frank, G. E. Hutchinson, W. K. Livingston, W. S. McCulloch, and N. Wiener. The New York Academy of Sciences, New York. $1.75 (paper). Pp. 187–278; ill. 1948.

Contents: Foreword (L. K. Frank); Time, Communication, and the Nervous System (Norbert Wiener); Circular Causal Systems in Ecology (G. Evelyn Hutchinson); The Vicious Circle in Causalgia (W. K. Livingston); A Recapitulation of the Theory, with a Forecast of Several Extensions (Warren S. McCulloch). These papers, with some of the discussion that followed the presentation of each one, are interesting but they do not reveal any close connection with one another in spite of their stated relation to teleology and its mechanics. Each to his own taste—most biologists will find the article by Hutchinson particularly valuable.

BENTLEY GLASS

NEW BIOLOGY. *Penguin Books. Number 7.*

Edited by M. L. Johnson and Michael Abercrombie. Penguin Books, West Drayton, Middlesex, England. 1s. 6d. (paper). 128 pp. + 8 plates; text ill. 1949.

Contents: The Behaviour of Livestock (Alastair N. Worden); Recent Work on Spiders (Theodore H. Savory); Flowering of Plants in Relation to Environment (O. V. S. Heath); Chromosomes (H. G. Callan); The Seaweeds and their Uses (Alan J. Brook); Defining Vitamins (Pauline Whitby); Famous Animals —2, The Tapeworm (M. L. Johnson).

THE NEW AUTHORITARIANISM. *Conway Memorial Lecture. Delivered at Conway Hall, on March 22, 1949.*

By Lancelot Hogben. Watts & Company, London. 2s. (paper). x + 44 pp. 1949.

In his Conway lecture a year ago Lancelot Hogben warmed to his subject by directing a number of savage thrusts at C. D. Darlington, Conway lecturer of the preceding year. The New Authoritarianism, which many a scientist today views with apprehension, is in Hogben's eyes an outcome, perhaps an inevitable outcome, of large-scale enterprise. The very growth of scientific knowledge makes it impossible any more for us to identify "the scientific outlook with refusal to take propositions about external or human nature *on trust.*" In higher levels of education and investigation the diminution of

"concern for rational grounds of confidence is evident on all sides. The constant pressure of foundations which finance research, diverts the eager curiosity of the young investigator by speeding up publication of results in any field of inquiry with an aura of novelty. The policy of our institutions of higher learning penalizes honest effort devoted to the exposition of science to students or public alike by allocating academic promotion solely on the basis of mileage covered by repetitive reprints. In universities or Government research stations, heads of departments ostensibly appointed by reason of capability to do original scientific work soon discover that they are paid to be supersalesmen of problems nobody can solve . . . the temper of science itself in this context becomes increasingly more authoritarian . . . the pity of it is the complacency we have in common with every pre-existing culture in its decline." "Increasingly elaborate techniques call for expenditure on a scale which necessitates the support of either the State or of private foundations; and the new patronage imposes a new discipline on the process of discovery, reshaping the outlook of its personnel. To justify the newer and more costly techniques it is necessary to show results. Accordingly, a memoir in a scientific journal is less now, as once in my own lifetime, the announcement of a new discovery than a progress report on a cash advance. . . . He who pays the piper calls the tune."

Hogben concluded by quoting the Nobel Prize speech by H. J. Muller, which emphasized that continued growth in the freedom of the human spirit in inquiry and communication must be paralleled by "the bringing of the benefits of modern techniques to all, the raising of the standard of living of the broad masses everywhere, not exclusive of any groups or races . . . so as to make high culture and free criticism not the unstable possession of a limited sector of society, as among the ancient Greeks, but a part of the accepted inheritance of all humanity."

BENTLEY GLASS

ESSAYS IN PHILOSOPHY AND OTHER PIECES.

By A. D. Ritchie. Longmans, Green and Company, London, New York and Toronto. 12s. 6d. viii + 208 pp. 1948.

In this collection of essays published over many years and in many places, the Scotch philosopher has dealt with several subjects of particular interest to biologists. In The Biological Approach to Philosophy he has adopted a holist view. "The essence of life is transience and change. . . . From the observation of living things we get perhaps the clearest indication of what is meant by transience and by history." It not only follows that the quantitative mathematical treatment of phenomena characteristic of classical physical theory is most glaringly insufficient in biology, but it also makes it unavoidable to consider in biology "the notion of purpose." But Ritchie does not attempt to consider the quantitative as well as qualitative aspects of genetic control of development, and his argument seems very weak.

In Antiphon: a Pseudo-Socratic Dialogue on Natural Religion, Ritchie has given us a brilliant dissection of specious epistemological views and the nature of scientific knowledge. In the beginning worthy of Lucian at his best, in its latter part the dialogue seems to weaken when it passes on to consider the arguments for the existence of the Deity. Yet as a whole it is very thought-provoking. An essay on Samuel Alexander, British philosopher who was devoted to an evolutionary view of the theory of knowledge and, like Lloyd Morgan, to evolutionary emergence, sketches the main lines of thought of one who ought to be more widely known among students of the influence of Darwinian concepts.

Charming writing is to be found in two slight essays at the end of the book, about the isle of Dochet and the ghost port of Letang, both near the boundary between Maine and New Brunswick. Other essays deal with: Freedon; Can Commonsense be Trusted?; The Ethics of Pacifism; Miracles; Magic in Modern Politics; Errors of Logical Positivism; The Atomic Theory as Metaphysics and as Science; The Logic of Question and Answer; A Defense of Aristotle's Logic; Theories of Immortality; and Sir Isaac Newton: the Man and his Influence.

BENTLEY GLASS

SCHOOL HEALTH EDUCATION. *A Textbook for Teachers, Nurses, and Other Professional Personnel. Harper's Series in School and Public Health Education, Physical Education, and Recreation.*

By Delbert Oberteuffer. Harper & Brothers, New York. $3.25. x + 405 pp. 1949.

This excellent text is the first of a new Harper's Series in School and Public Health Education, Physical Education, and Recreation, to be edited by the author. Written primarily for college and university students preparing to teach health education, it presents a comprehensive picture of a school health program, and describes the pedagogic techniques and principles being employed most successfully in the field of health education in our schools today.

The textual materials are presented under three broad headings: namely, (1) The Foundations of School Health Education; (2) The Curriculum and Teaching; and (3) Administration and Activities. Under The Foundations of School Health Education, the needs which have given rise to programs of school health education are discussed in relation to the school's responsibility in meeting those needs. The section on The Curriculum and Teaching covers the organization and techniques being widely used in courses of health education throughout the country at the present time. A sufficient variety of methods and materials are suggested here to meet the needs of a wide range of classroom situations and teaching techniques. The chapters in the section on Administration and Activities deal with the functioning of the school health program as it relates to the individual, family, and community. The discussions here are concerned with the problems of the handicapped, nutrition, safety, dental health, the control of communicable diseases, and the general techniques for measuring the effectiveness of the school health program. The volume will undoubtedly find a popular place in the field of methodology in health education. An index is provided.

B. AUBREY SCHNEIDER

TRENDS IN MEDICAL EDUCATION. *The New York Academy of Medicine Institute on Medical Education, 1947.*

Edited by Mahlon Ashford. The Commonwealth Fund, New York; Geoffrey Cumberlege, Oxford University Press, London. $3.00. xiv + 320 pp. 1949.

This book covers the proceedings of a series of conferences held in April 1947 under the auspices of the Committee on Medical Education of the New York Academy of Medicine, and deals with current problems and trends in medical education. The panels and round table discussions are fully reported and include the following subjects: Premedical Education and the Selection of Medical Students, Undergraduate Medical Education, The Medical Education of Interns and Residents, Graduate and Postgraduate Training for Specialization, The Responsibility of Medical Schools and Hospitals in the Education of the General Practitioner, and The Relation of Group Practice and Community Medical Services to Medical Education.

DAVID B. TYLER

BIOLOGY: HISTORY AND BIOGRAPHY

BOTANIK DER GEGENWART UND VORZEIT *in Culturhistorischer Entwickelung. Ein Beitrag zur Geschichte der Abendländischen Völker. Pallas, Volume I.*

By Karl F. W. Jessen. [*F. U. Brockhaus, Leipzig*]; *The Chronica Botanica Company, Waltham; Stechert-Hafner, New York City.* $6.00 (paper). xxii + 495 pp. [1864]; 1948.

Eleven years before Sachs published his history of botany, which has long maintained its preeminence in its field, Jessen published this history of botany in relation to the history of culture. Sachs' history has been particularly valuable for its thorough treatment of 19th century plant physiology. Jessen's is unique for its cultural approach, which leads the editor, Frans Verdoorn, to acclaim it in the words: "little known as it may be at present, [it] is the best concise, all-around history of botany ever attempted." It has been reproduced by photo-offset, even to the original title-page. This will involve one inconvenience for most non-German readers, namely, the German Gothic script and the 19th century spellings, which scientists are not so accustomed to as are those in literary or philosophic fields. It is a very slight drawback—or perhaps none at all, depending on one's point of view—compared to the advantage of being able one's self to possess this valuable history. This is a most auspicious beginning of the Pallas series, in which Frans Verdoorn plans to bring us other out-of-print and classic scientific works.

BENTLEY GLASS

GOETHE ON NATURE AND ON SCIENCE. *Second Edition. The Philip Maurice Deneke Lecture Delivered at Lady Margaret Hall, Oxford, on the 4th March 1942. By Sir Charles Sherrington. Cambridge University Press, Cambridge, London, and New York.* 2s. 6d. 54 pp. 1949.

This delightful hour with Goethe and Sherrington is the Philip Maurice Deneke Lecture delivered at Oxford on March 4, 1942, and first published in that eventful year. For the present edition the author has "worked over the whole lecture again." It is a careful and well documented study, and full of the flavor of the irresistible but often impossible Goethe.

Although Goethe was an ardent student of Nature and the Sciences, and gave to the study of the shapes assumed by life the name by which it is now universally known, *morphology*, nevertheless Sherrington concludes:

"Were it not for Goethe's poetry, surely it is true to say we should no longer trouble about his science. Such as it was, it is as science not important. . . . His enthusiasm as an observer of nature was great. But a new fact he met with was apt to send him on a flight of imagination into the unknown. Creative genius in literature, in science his genius longed to create. It could not always abide the waiting for further experiments and more knowledge. . . . Goethe, though devoted to science, had not at root the scientific temperament. He had not, for instance, along with the urge to discovery the sublime detachment of the scientific thinkers."

In Goethe's time there had arisen a desire to catalogue and arrange in order all the kinds of plants that are, the assumption of the time being that the kinds around us are still as at the creation of the world. Goethe, however, had noticed such differences between specimens of the same species that he thought specific form might be in a state of flux. The continual change which he suspected was going on in plant form Goethe attributed to the influence of environmental conditions, such as type of soil, light, warmth, moisture, etc. Thus both Goethe and Lamarck dissented from the Linnean "frozen" view of species, although the latter was the orthodox view. One recalls that the isotopic evidence of the continuous interchange of protein amino nitrogen with the environment did not then intrigue observers of biological continuity, and altogether there has been many a mutation since Goethe sang of change and flux.

However, many of Goethe's ideas were less fortunate. For example,

"Goethe never reconciled himself to the Newtonian notion of light, although it became the standby on the subject for the scientific world. . . . In following Goethe's science, we are helped by his having laid down principles which in his view should govern scientific observations. One of them is that the conditions for observations should be kept as simple as possible, and for that reason should eschew apparatus. Prominent in his objections to the prism experiment was that the prism introduced heaven-knows-what complications. Essential for scientific observation was *Anschaulichkeit* 'obviousness' or 'naked clarity.' This clarity could dispense with mathematics, . . . which had brought calamity to optics. He did not see that the use of apparatus is to simplify conditions. Nor, again, that mathematics can be a main means toward obtaining *Anschaulichkeit*.

"As regards science, Goethe lay becalmed, so to say, in a small quasi-scientific backwater of no great account. But Boyle had been starting modern chemistry, and Lavoisier, Cavendish and Dalton had established it. Lagrange and Laplace had annexed the nearer heavens for Newton. [This while Goethe was dealing with material forces by notions ad hoc out of his own fancy.] Further, Goethe's pronouncements were shot through with anthropomorphism, which, unless used purely as metaphor, *is* the occult. In Goethe it *is* the occult. *Polarität, morphogenesis*, and so on, have 'yearnings,' 'likes,' 'will,' etc. We are back in the mediaevum and early renaissance."

Goethe's isolation from the main stream of the science of his time finds an interesting parallel in a sort of political becalm, a lack of insight into the significance of the French Revolution and a failure to appreciate its positive aspects. Although he does not stress the parallel, Sherrington finds that "the *sans culottes* of the revolution were to him a hopeless problem as well as a repellant mob. Thompson's poem on 'Liberty' failed because 'there was no poetry in the theme "Liberty."' The cry *égalité* was hateful to him, even in its context of that great assertion of the rights of man, that doing away with feudal privilege.

Alas, that our men of letters do not always exhibit

an insight into their times that is of a quality with their eloquence. Goethe is our friend, "but the truth is even more our friend."

EVELYN HOWARD

LIBERTY HYDE BAILEY. *A Story of American Plant Sciences.*

By Andrew Denny Rodgers III. Princeton University Press, Princeton. $7.50 viii + 7 plates. 1949.

Liberty Hyde Bailey, the most recent of Andrew Denny Rodgers' series dealing with eminent botanists, is far more than a mere biography. Rather, it is a comprehensive survey of the development of scientific agriculture in the United States and Canada, and an account of the advances made in botany and zoology during the present Century. Liberty Hyde Bailey is the central figure in this great drama, and any account of his life and work must of necessity be primarily concerned with the great achievements in plant science for which he was wholly or in part responsible.

The story of the founding and development of the United States Department of Agriculture, the establishment of agricultural colleges and of departments of agricultural science in many older institutions, and the setting up of the nation-wide chain of agricultural experiment stations form the background of this book. Interwoven with this framework is a fascinating account of the work of the stations, the advances in experimental research, and the initiation of entirely new branches of science, such as horticulture, plant breeding, and phytopathology. Through it all runs the thread of Bailey's own career, from its humble beginnings on his father's Michigan farm to his present honored position as the nestor of American botany. Few men have contributed so much to plant science and to the welfare of the rural population. Horticulture, floriculture, scientific agriculture, forestry, nature study, rural life education, and taxonomy have all benefited directly. Whether as Professor or as Dean, as the world's leading agricultural author and editor or as Chairman of the Country Life Commission for the improvement of country living, his influence has been great.

The story of the last fifty years and more of plant science in the United States, however, is more than the story of one man's accomplishments, however great they may be. In the author's presentation scores of other botanists play a part and their work is evaluated and brought into proper focus.

The book is so full of factual information derived from letters, documents, collections, and all other available records that no review can begin to do it justice. It must be read to be appreciated—and read at one's leisure—in order to assimilate the wealth of material within its pages. Suffice it to say, *Liberty Hyde Bailey* is a worthy successor to *Noble Fellow, John Merle Coulter*, and *John Torrey*, and carries the saga of North American botany another step nearer completion.

ALBERT F. HILL

LE FRÈRE MARIE-VICTORIN ET SON TEMPS. *"Voyez les Lis des Champs."*

By Robert Rumilly. Les Frères des Écoles Chrétiennes, Montréal. $2.00. (paper). ii + 459 pp. + 41 plates. 1949.

Frère Marie-Victorin was born at Kingsley Falls on April 3, 1885. He was baptized Joseph Cyrille Conrad Kirouac. The Kirouac family traced itself back into the Middle Ages, and its first representative came to New France in 1730. The young Conrad was educated at L'Académie (Commerciale) de Québec, and in 1901 became a novitiate at Mont de la Salle in Montréal. Throughout the remainder of his life, he was a lay brother associated with this organization. Early in life he became interested in botanical research and exploration and continued his work in this field until his death. He was widely known and appreciated as a taxonomist and plant geographer through the world, and was a leading figure in the development of modern botanical research and instruction in French Canada. The present volume will be of great interest and value to his many friends, associates, and students. It appears to be a rather definitive biography, dealing not only with Brother Marie-Victorin's many accomplishments, but with the influences that shaped his life. The book is profusely illustrated with photographs, is arranged with explanatory chapter headings, and contains an extensive index.

H. M. RAUP

AMERICAN HEARTWOOD.

By Donald Culross Peattie; decorations by David Hendrickson. Houghton Mifflin Company, Boston. $3.50. x + 307 pp.; ill. 1949.

In his usual colorful language Peattie has reviewed the common heritage of all Americans, our trees. He parallels the history of our nation with the development of the sturdy heartwood of a tree, "widening ring by ring and year by year—seeking a tall, straight way toward the highest light." Here is a most pleasant way to appreciate the nation's growth, "for man and trees are partners in the American story." Following the exploration and trial settlement of the Icelander Erik the Red, we are taken through The Groves of Columbus, learning such unfamiliar facts as that the generous natives gave Columbus "some dried brown leaves," the offer of which he failed to appreciate, so discarding tobacco without knowing that this present was worth "more in gold than all the spices" he sought. His quest, in fact, was for rhubarb! Peattie leans heavily

on his own familiarity with the wooded land and deserts through which the Spanish searched for gold, but concludes his account of their ruthless expeditions with the comment that Sante Fe "is Spanish country still, with the gold leaf of the Spanish tradition laid on the crude carving of the Indian way of life."

Amidst the long leaf pines the story of John White is unfolded—that of the first man to have a scientific and artistic appreciation of American greenery. John Smith comes to life in his record that "The country is most overgrown with pynes—the wood that is most common is Oke and walnut . . . ." A succession of stalwarts—Roger Williams, William Penn, John Marshall, Andrew Jackson and others—come down to us, each surrounded by a heritage involving trees. The subject extends into forceful chapters on Old Ironsides, herds of bison, and Virginia City. Threaded throughout is discussion of Peattie's forthcoming treatment of the northeastern sylva, showing that here is one book about another. In writing *American Heartwood*, the author explains that "this book of mine is for me a holiday. I am journeying in it where my fancy takes me. And when you are making ready such a journey, you put in what you please, and leave out whatever you don't care to be bothered with. Such irresponsibility would never have done, in the book I have just finished about trees." So it is that the reader comes to know Peattie's home in Santa Barbara and the great oaks which protect it and inspire him.

For anyone who has roamed these United States this book combines new facts, smooth writing, and reminders of personal experiences in many places. It is rich in history and nature, for no matter when or where one travels, "the wonderfully steadying thing about the identities in Nature is that they do not change through all the desperate flux of men's affairs." The book deserves an index.

LORUS J. AND MARGERY MILNE

NATURALIST'S SOUTH PACIFIC EXPEDITION: FIJI. *By Otto Degener. Paradise of the Pacific, Honolulu.* $5.00. viii + 303 pp.; ill. 1949.

Otto Degener was guest botanist to the second "Cheng Ho" expedition in 1940-41. The expedition was under the sponsorship of Mrs. Anne Archbold, and undertook primarily scientific exploration among the Fiji and neighboring islands. It set out from the Philippines in the latter part of 1940 and went directly to the Fiji Islands. There Degener left the ship and spent the remainder of his membership in the expedition collecting plants. During some eight months' work, he accumulated about 2100 collection numbers of Fijian plants, which were sent for study and determination to Albert C. Smith of the Arnold Arboretum and to other specialists. E. D. Merrill, then Director of the Arnold Arboretum, and W. J. Robbins, Director of the New York Botanical Garden, were in general charge of the handling and distribution of the collections.

Degener's book, though it contains as an appendix a numerical list of the collections, is primarily a non-technical account of his travels and experiences in the Fiji Islands. It is eminently readable, lively, and interesting. It is profusely illustrated with modern photographs and reproductions of old prints. Degener is a man of wide experience in travel and botanical exploration in the Pacific. He has been extraordinarily successful at training native assistants, who have served him not only in a technical capacity for his botanical work, but as informants on native lore. The author's botanical experiences are interspersed throughout the book with colorful descriptions of the native life and its setting, and with his quite uninhibited comments upon what he thinks of native customs, British colonial policy, the efforts of missionaries, and the future of the country. There are intriguing chapters, for instance, on native hair-dos, the institution of cannibalism, and races of man in the Pacific.

H. M. RAUP

SVALÖF 1886-1946. *History and Present Problems. Edited by A. Akerman, O. Tedin, and K. Fröier; English technical editor, R. O. Whyte. Carl Bloms Boktryckeri, Lund.* Kr. 20.00; $6.00. vi + 389 pp.; ill. 1948.

This interesting collection of papers presents a survey of the 60 years of scientific plant breeding carried on by the Swedish Seed Association at the Svalöf Institute. The book was prepared in the hope that it might reaffirm the desire of Svalöf to participate in programs involving international cooperation in genetical research. Each of the 22 separate articles was prepared by a specialist. Some of them are general in nature and deal with the history of the Institute, its organization, or such topics as climate and soils, biochemistry, and the publications of the Seed Association. Others outline the principles underlying the experimental work or are concerned with the experience gained in recent years. Of particular interest are the chapters devoted to the more modern fields of investigation—cytogenetics, polyploidy, and x-ray breeding. A wide range of plants is discussed, including wheat, oats, barley, rye, potatoes, root crops, oil plants, flax, hemp, herbage plants, alfalfa, and others of minor importance. The excellent typography and illustrations add much to the value of the book.

ALBERT F. HILL

HUANG TI NEI CHING SU WEN. *The Yellow Emperor's Classic of Internal Medicine. Chapters 1-34. Translated from the Chinese with an Introductory Study.*

By Ilza Veith. The Williams & Wilkins Company, Baltimore. $5.00. xx + 253 pp.; ill. 1949.

This is a translation of the first 34 chapters of *The Yellow Emperor's Canon of Internal Medicine*, the most famous Chinese classic on the subject. The legendary Yellow Emperor, Huang Ti, lived supposedly between 2697 and 2597 B.C. The book that bears his name was probably composed in the first millennium B.C. The text that served as a basis for the translation stems from the eighth century A.D.

The translated chapters are in the form of dialogues between the Emperor and his minister Chi Pai on the problems of disease and the healthy and good life, in the framework of Chinese basic natural philosophy (Tao, Yin and Yang). In typical Chinese fashion organs are related to these basic principles, to elements, and to seasons in an elaborate system of mystical numbers. The fundamental approach in diagnostics (the pulse) and the nature of therapeutics are discussed. Moxa and acupuncture are treated in more detail. Whether that most important element of Chinese medicine, its pharmacopoeia, is absent only from the translated chapters or from the whole book, is not mentioned by the translator.

This first translation of important parts of a Chinese medical classic into English is a medicohistorical event, the magnitude of which needs no further elaboration. All those who have contributed to it, especially Ilza Veith, the late J. W. Lindau, H. E. Sigerist, and the publishers, deserve our heartfelt gratitude. Ilza Veith, who has so successfully struggled with one of the most difficult tasks imaginable in the art of translating, has enhanced the value of her book by an excellent historical introduction and well chosen illustrations. The printers have also done well in a difficult task requiring the combination of ideographs with our own letters.

ERWIN H. ACKERKNECHT

VOLUMEN MEDICINAE PARAMIRUM OF THEOPHRASTUS VON HOHENHEIM CALLED PARACELSUS. *Supplements of the Bulletin of the History of Medicine, Number 11.*

Translated from the original German with a Preface by Kurt F. Leidecker. The Johns Hopkins Press, Baltimore. $1.75 (paper). viii + 69 pp. 1949.

In this little treatise the famous sixteenth century physician and "reformer of medicine" gave his opinion on the cause of disease. Disease, he thought, is not a product of the bad mixture of the four humors, as assumed by his predecessors, but stems from five sources: the ens astrale, the ens veneni, the ens naturale, the ens spirituale, and the ens Dei. The development of the human body is not conditioned by the constellation of stars at birth, as the astrologists claim. This is caused by an ens seminis (genes?). But the stars produce disease through poisonous gases. This is the ens astrale. Every food can poison, when the "alchemist" of the body fails. This is the ens veneni, in a way an anticipation of metabolic disease. The body is a microcosm. Its sun is the heart, its moon the brain, its Jupiter the liver, its Saturn the spleen, its Venus the kidneys. Out of the "constellation" of these "planets" disease may arise. This is the ens naturale. Attack of the will of another person on one's own will, with or without sorcery, may create disease. This is the ens spirituale. That this chapter sounds often like our "psychosomatic" reasoning is as much the product of the immaturity of our own psychology as it is a matter of Paracelsus' foresight. The last cause of disease is the will of God (ens Dei). It is also only God's will that heals through the physician. God sends disease as an affliction, and it cannot, therefore, ultimately be understood.

The treatise is a fair specimen of Paracelsian thought: a strange mixture of some great sense and far more nonsense. Longwinded and mystical as usual, it is relatively poor in his customary outbreaks of invectives and megalomania. Paracelsus' great "reform" consisted in replacing an old speculative system with a new speculative system, based no longer on exclusive "pagan" rationalism, but on a Christian mysticism that might be emotionally sympathetic, but is scientifically sterile. Yet Paracelsus has to be studied, whether one regards him as a great thinker and physician, as his translator does, or as neither, as it seems to the reviewer. Yet Paracelsus, and not Vesalius, Fernelius, or Fracastorius, was the representative physician of his time. From this point of view the Hopkins Institute of the History of Medicine is to be congratulated that it continues to make available the Paracelsus texts in good English translations.

ERWIN H. ACKERKNECHT

LIFE AMONG THE DOCTORS.

By Paul De Kruif, in collaboration with Rhea De Kruif. Harcourt, Brace and Company, New York. $4.75. x + 470 pp. 1949.

De Kruif's latest book follows very much the pattern of his earlier successes: a bouquet of biographies, this time of "doctors," pioneer medical scientists of our time. Three of them are remarkable public health men: C. C. Young, Herman N. Bundesen, and O. C. Wenger. There are portraits of Tom Spies of vitamin fame, Al Coburn, fighter against rheumatic fever, Leo Loewe, who tackled S. B. E., the neurologist Herman Kabat, Sidney Garfield of the Kaiser Health Plan, and the "great old man" of American medicine, (probably L. Hektoen), fighting cancer, who wants to remain anonymous. The same "corny" old plot is used: the hero, creating a miracle, is continously harassed by the villain, in this case the medical profession. The same old cheap, "breezy," style, full of slang expressions, prevails. DeKruif's popularity as a writer seems to be based

mainly on the fact that the unfortunate average citizen of this ex-puritan country has still guilt feelings even when swearing or drinking, and cannot help but admire a man who does not suffer from his inhibitions and lets out a Goddam every so often.

But this book, which pretends to contain a message for the salvation of mankind through scientific medicine, is not primarily a problem of style and taste, but of *truth*. It must be stated that it contains mostly half-truths. All the men DeKruif has described are in a way admirable men, but none of them has played exactly the role DeKruif attributes to him. As a historian DeKruif is so careless with facts that he does not even get the first name of the discoverer of vaccination straight. As to the "villain," the medical profession, this reviewer, though himself an M. D., feels free enough from prejudice to admit regretfully that about 50 per cent of the author's accusations are truthful. When, on the other hand, the author repeatedly claims that "doctors" are opposed not to social but to medical progress because they fear to lose their business, the accusation is not only monstrous, it is untrue. Doctors are fortunately a lot better than their official representatives try to make them look. (DeKruif proves his fundamental lack of seriousness by making an indirect recantation of all his accusations in the preface to a second edition, just because in the meantime the American Medical Association dismissed its editor, a man whom DeKruif happens strongly to dislike. That the A. M. A. continues to pursue the same policies through some even more objectionable characters seems not to bother a subjectivist of DeKruif's sort.)

There are a few things that the author, when judging doctors, either does not know or does not understand: for instance, that all his miracle drugs are of little benefit to 70 per cent of an average doctor's clientele, or that treatments not only cure, but often also kill. Failure or toxicity of drugs are practically not in DeKruif's vocabulary.

The reviewer has had to think about this book a good deal, because it is in many ways highly stimulating through its criticism and its enthusiasm. Regretfully he has to admit that he has been unable to reach a clear-cut decision. As a scientist, wedded to the "whole truth," he would utterly condemn it. But in a field so heavily obscured by the smoke of straight untruth used as propaganda, even to read half-truths might prove of some positive value.

ERWIN H. ACKERKNECHT

THE WORKS OF GEORGE BERKELEY, BISHOP OF CLOYNE. *Volume I. Philosophical Commentaries; Essay Towards a New Theory of Vision; Theory of Vision Vindicated,*

Edited by A. A. Luce. Thomas Nelson and Sons Ltd., London, Edinburgh, Paris, Melbourne, Toronto, and New York. 30s. net (provisional). viii + 279 pp. 1948.

This is the first of a series of eight or nine volumes planned on the works of George Berkeley. The present volume contains three of Berkeley's writings: *Philosophical Commentaries, An Essay Towards a New Theory of Vision* and *The Theory of Vision or Visual Language Shewing the Immediate Presence and Providence of a Deity Vindicated and Explained.*

The *Philosophical Commentaries* is actually a collection of some 900 notes, not intended for publication, and originally contained in two notebooks. They are jottings that Berkeley made of the thoughts and queries that he had when he was trying to work out his theory of vision and his metaphysical doctrine. The entries are at first glance bewildering and disconnected, but it is easy to see here the antecedents of arguments which found their way into his later writings. The *Essay* is a classic in the history of psychology and philosophy. In it, Berkeley carefully analysed the psychological cues for the perception of size and distance and laid the groundwork for many of our current ideas on the subject. *The Theory of Vision* was a shorter work, written in reply to an anonymous critic of Berkeley's *Essay*. The entire collection is carefully and minutely annotated by the editor.

A. CHAPANIS

ECOLOGY AND NATURAL HISTORY

BOTANY OF THE CANADIAN EASTERN ARCTIC. *Vegetation and Ecology, Part III. National Museum of Canada, Bulletin Number 104, Biological Series Number 32. By Nicholas Polunin. National Museum of Canada, Department of Mines and Resources, Mines and Geology Branch, Ottawa.* 75 cents (paper). viii + 304 pp. + 1 map; text ill. 1948.

Part III of Polunin's series on the botany of Eastern Arctic Canada was actually finished in the early years of the last war, and its publication was thus greatly delayed. Part I, consisting of a catalogue of the vascular flora, was published in 1940; and Part II, a catalogue of the non-vascular plants, came out in 1947. Part IV, projected for the future, is designed to cover certain features of the "sub-Arctic" regions.

The present volume is well written, and profusely illustrated with photographs. There are 107 of these plates. Two maps are given, one a sketch map at the beginning of the book showing the geographical divisions used in the text, and the other a larger, more detailed map of the Eastern Arctic, folded and placed in a pocket at the back.

The general plan of the book is on a geographic basis. Ten subdivisions of the area are recognized, as

follows: 1) Ellesmere Island; 2) Devon, Cornwallis, and Somerset Islands; 3) the northern part of Baffin Island; 4) central Baffin Island, including Cumberland Peninsula, the land around Cumberland Sound, and Nettilling Lake; 5) southern Baffin Island, including the Foxe Peninsula; 6) the Melville Peninsula; 7) northernmost Labrador, consisting of the small tip of the peninsula east of Ungava Bay and north of the 60th parallel; 8) northernmost Quebec south to the 60th parallel; 9) the islands in Hudson and Ungava Bays, such as Southampton, Coats, Mansel, and Akpatok; 10) the west coast of Hudson Bay south to latitude 60 and including all of Wager Bay. Descriptions of vegetation and local ecology are given for each of these areas, with the pattern of treatment repeated in each area. A list of headings for the treatment of Ellesmere will be fairly typical. First come sections on geology, climate, and a general treatment of vegetation types. These are followed by more or less detailed descriptions of specific areas visited by Polunin himself. In the case of Ellesmere Island, the locality was at Craig Harbour, and the communities are described under the following headings: uplands; scree and other slopes; lowlands; marsh; snow effect; special localized habitats and communities; fresh water; strand; and marine.

The book contains, usually under the general description of the vegetation in the various geographic areas, a wealth of material gleaned from earlier travel and description. Those who have undertaken this kind of research will appreciate the immense amount of painstaking labor that went into the gleaning of these historical data. Most travelers do not describe vegetation in terms that are specific enough for a plant geographer. Nevertheless, when one is familiar with the general botanical landscape in which the travelers have lived, it often becomes possible to make quite accurate interpretations of their sketchy accounts of vegetation. Polunin has succeeded in doing this effectively for many areas.

This reviewer would like very much to have had the author make some attempts at generalization within the huge mass of material that he has presented. Even though such generalizations would have given rise to controversy over concepts, and would have been based upon many uncertain premises, yet they would have been stimulating. This is especially true when the nature of the development of Arctic vegetation is being studied intensively, as it is now. Polunin presents the following defense of his lack of attempt at generalization.

"In tackling what is thus an almost virgin though huge field I have been struck by two apparent anomalies. The first was that the vegetation of the southern part of the area was even less known than that of the north, though this is not inconsistent with the northward trend of exploratory activity of the past few decades. The second has been that the more I learned about the vegetation of the area as a whole, the less I felt inclined to generalize about it; for if one impression stands out from among all my studies of the vegetation of the Canadian Eastern Arctic, it is that of extreme (and often to me inexplicable) variability from place to place. Certainly there will long remain a great deal more to discover; nor is our knowledge as yet nearly sufficient to allow of detailed comparison with other arctic or subarctic lands."

Anyone who has attempted to describe tundra vegetation will know what is meant by this. It points clearly to a conclusion reached by Griggs and others that the tundra vegetation will not yield to analysis by the methods usually used in the temperate regions, and that new methods and points of view must be constructed.

H. M. RAUP

PILCHUCK. *The Life of a Mountain. By Harry W. Higman and Earl J. Larrison. Superior Publishing Company, Seattle.* $3.50. xiv + 288 pp. 1949.

Pilchuck, the subject of this story, is an isolated mountain in the Cascades of Washington. The authors have selected it because its isolation makes it relatively easy to consider as an ecological unit (if such a unit ever exists). The story of the life on this mountain is told in popular style, in such a manner that even a simple incident becomes interesting. The authors have employed a very clever device to carry their story in centering it around the observations of three friends who spend all their available time exploring the mountain. One of these friends, an educated amateur naturalist, writes in the first person and thus brings the other two into the narrative. The second man is a professional ecologist, and the third an untutored naturalist, representing the modern counterpart of a frontiersman. The discussions that go on among these men enable the authors to present various views and arguments relating to the ecological problems of the mountain.

The result is a book that portrays, as well as any the reviewer has read, the great personal satisfaction and pleasure that can be derived from studying ecology, as well as the relative ease with which even an amateur can start such work. The scientific values of these studies are also clearly brought out in various discussions relating to soil conservation and wildlife management. Interested amateur readers might well use this book as a guide for starting similar projects of their own, selecting isolated ecological "units" such as islands, beaches, ponds, or stretches of streams for study.

JOHN CUSHING

HIGH JUNGLE.

By William Beebe. Duell, Sloan and Pearce, New York. $4.50. xii + 379 pp. + 32 plates; text ill. 1949.

"High Jungle" is the region around Portachuelo Pass across the Cordillera of Venezuela. Here, in the enormous half-finished concrete palace of an extinct dictator, Beebe and his associates established a biological laboratory. For three seasons (1945, 1946, 1948) they studied the passing procession of birds, moths, beetles, monkeys, snakes, frogs, ants, and innumerable other animal species, as it passed before the backdrop of giant trees and lianas, tree ferns, orchids, and other jungle plants. Off to the north, a few miles of precipitous drop to the blue Caribbean; off to the south, and far below the verandas of Rancho Grande, the brown, dusty savanna, the lights of Maracay, and the glistening waters of Lake Valencia; in the Pass, alternating sunshine and fog revealing and concealing the teeming life of the high jungle, and modifying its ways as much as its appearance.

In the thirty years since *Jungle Peace*, Beebe's first popular book, his observation has lost none of its keenness, his prose none of its color. Whether he is describing the giant 6-inch land planarians or the great gray frog which hatches its young from its own back, the lives of the jungle falcons or the inconceivable swarms of moths beating at night through the Pass and against the lighted windows of the laboratory, or the fantastic moth which builds a palisade for its caterpillars out of its own scales, Beebe's zest never flags. The book contains numerous excellent illustrations from the expedition's photographs. In short, *High Jungle* is a fine addition to a great series of books of natural history.

BENTLEY GLASS

THE SEA SHORE. *The New Naturalist: A Survey of British Natural History.*

By C. M. Yonge. Collins, London. 21s. xvi + 311 pp. + 72 plates; text ill. 1949.

This book is the culmination of more than a hundred years of such books about the seashore life of Britain. The author is fully aware of this long and honorable tradition, as his historical chapter, bibliographic appendix, and the use of charming quotations from his predecessors as chapter headings alike indicate. Many of these books were well, if not quaintly, written and illustrated with meticulously accurate paintings and precise drawings. Others were miserable hack work now deservedly forgotten. Now, with the aid of a master photographer, Yonge has left almost nothing for his successors in England to add or improve upon, and has set up a model for anyone who undertakes to write about another shore.

Although the subject of this book is the intertidal zone of the English coast and its plants and animals, it is not a provincial book. The chapters on the nature of the shore (except for the discussion of tides, which applies to English shores specifically), borers into rock and wood, sandy shores, estuaries, and shore populations, to name some of the most outstanding, are drawn from the author's wide experience and are applicable anywhere. In addition to being highly readable, they deserve to be used as reading assignments for students in seashore biology classes, both on account of their subject matter and as an antidote for the dry diet of textbooks and wilted reprints. The whole book is a blend of personal experience and observations with the recent issues of the *Journal of the Marine Biological Association*.

The photographs, most of them by Douglas P. Wilson, are almost beyond compare, and will be the despair of all other photographers. To see the coast of England, as shown on these color plates, is certainly a very fine second best to an actual visit to the scenes. As for the portraits of the animals themselves, no better photography has ever been published. There are things the camera still cannot do, in so far as the precise requirements of the taxonomist are concerned, but the margin between the camera and the lithographer's stone is narrowing down. The printers have risen to the occasion, and the color work is on the whole excellent.

JOEL W. HEDGPETH

AMERICAN SPIDERS. *The New Illustrated Naturalist.*

By Willis J. Gertsch. D. Van Nostrand Company, New York, Toronto and London. $6.95. xiv + 285 pp. + 70 plates. 1949.

It is with extreme pleasure that this reviewer reports on *American* Spiders, the second volume in the New Illustrated Naturalist series. This excellent book represents the result of almost a quarter of a century of laboratory and field work of one of our leading araneologists. While all specialists will naturally want a copy, it may prove to be of even more value to the general biologist, the entomologist, and particularly the naturalist, who will be delighted to discover the fascinating attributes of spiders.

The first few pages are devoted to a discussion of the place of spiders among other animals in nature, and to a brief description of their general morphology. The greater part of the book is given over to the habits and lives of these creatures, including their embryonic development, hatching, growth and molting, feeding habits, autotomy, and longevity. While most people may think of spiders' habits only in terms of webs spun to entrap prey, Gertsch has elaborated on the many other uses to which spiders put their silk,

e.g., nursery webs, hibernating chambers, ballooning lines, egg sacs, and a host of others. Also included is an account of how human beings, too, have used the silk, as fishing nets in Papua, as cloth for garments, or as cross-hairs in optical instruments. Besides mentioning the role of spiders in classic myths, Gertsch also recounts many little-known legends which show the importance attached to spiders by numerous primitive tribes.

An entire chapter is devoted to the sexual behavior of spiders, their remarkable courtship habits and mating positions being described in great detail. It is regrettable that the morphology of the reproductive organs has not been described sufficiently, and that not a single illustration of these organs was included. The reader who is unfamiliar with spiders may not entirely comprehend the discussion without reference figures, while for the specialist figures would have been useful in lending support to the "lock and key" theory, to which the author adheres. Another omission from the book is any consideration of the parasites of spiders.

Although a few of the more common or conspicuously marked species may be identified from the author's descriptive notes or from the illustrations, the volume is not intended as an aid in determining species, so that for this purpose recourse must still be had to manuals. Information about the different families has been grouped under four headings, and for each heading a separate chapter is reserved. These include first the tarantula and trap-door spiders, then the hackled band weavers, third the aerial web spinners (including the majority of spiders known to the casual observer), and finally the vagabond hunters (such as wolf and crab spiders) which do not build snares. To most readers the well-authenticated accounts of the spitting spider, of the bolas-throwing spider, and of those that catch fish, will seem almost incredible.

Considerable space is devoted to the economic importance of spiders, especially to arachnidism. After a background survey of the legends surrounding the Italian "tarantula" (in reality a wolf spider), one is introduced to the several species of which the bites are known to be dangerous to man. A full account is given of the black widow, its control, symptoms of its bite, and the remedies that have been found useful in alleviating symptoms.

The final chapter deals with the relationships and affinities of the North American spider fauna, and includes a scheme of classification different from the usual one, in which the liphistiids are placed by themselves in a separate suborder. The author advances some convincing reasons for classing these primitive spiders with the purse-web weavers, the folding trap-door spiders, and others, as atypical tarantulas, in the same suborder with the typical tarantulas and their allies. Certain other groups generally considered families have been sunk to subfamily status, and a number of the subfamilies have been elevated to higher rank. The book closes with a glossary of technical terms, a short bibliography, and an index.

The volume is superbly illustrated with 32 plates in full color and 32 in gravure. Most of these are by outstanding masters of the photographic art and are in themselves important contributions to spider study. The publishers are to be congratulated upon combining so well the work of these men with that of W. J. Gertsch. Undoubtedly the numerous minor typographic errors will be corrected in time for the next printing, thus improving a book that will in all probability long remain *the* outstanding volume on these much maligned but extremely interesting animals.

B. J. KASTON

WEBS IN THE WIND. *The Habits of Web-Weaving Spiders.*

By Winifred Duncan. The Ronald Press Company, New York. $4.50. xvi + 387 pp.; ill. 1949.

The best thing about this book is its title, but that lyrical phrase is only a deceptive lure to read a volume which has a sickeningly coy style throughout. In the preface the author states: "It has long been my intention to select some little creature concerning which I know nothing, make a careful study of its life, and write a book about it which would take the reader along with me, step by step, on a voyage of discovery." Undoubtedly the author was sincere in this laudable aim. However, the following comments should be sufficient to show that by using the methods she chose the author's voyage of discovery could end only in catastrophe. To enumerate all the errors of fact, misspellings, misinterpretations, and imagined occurrences would more than fill the space allotted here.

After stating her reasons for choosing spiders for study, she continues: "... it is the more amazing that so little work has been done in this field...." Her bibliography contains but 14 titles, and it is evident throughout the book that the author is completely unaware of the vast amount of work that has been done on this group within the past half century, not only in America but elsewhere in the world. Yet she feels qualified to condemn previous workers with words such as these: "with his usual inaccuracy" Comstock states; or Hingston is "rather too apt to make general conclusions from insufficient data." The latter statement is especially startling when coming from a worker who indicates that she ceased her observations after 10 minutes, because she was tired, and yet will make dogmatic statements based on virtually no evidence.

Winifred Duncan resolved that her book would contain no information rehashed from other books, nor any borrowed drawings. Almost immediately, however, curiosity overcame her and she "peeped into just

one old spider book I happened to have to verify my own observations." Later she bought more books into which she peeped and from which she extracts "quotations." At least the passages are given as quotations, although upon checking them this reviewer discovered that they were paraphrases which, more often than not, misinterpreted the original. Very often the source is not mentioned beyond a vague "books say."

After observing a few specimens, or even one individual, Miss Duncan drew sweeping conclusions for entire genera, and in some cases families, although it is well known that behavior may vary even among individuals of the same species. She triumphantly records that the authorities in books do not agree with her, and that they are, therefore, wrong. Although she observed a few spiders on Cape Cod in May, a few in California in September, and the majority about which she writes during the winter months in Mexico, she frequently lumps together observations on several species or genera in the mistaken notion that they belong together. Some chapters deal with unidentified spiders for which she has invented such appellations as the Green Princess, the Baby Faun, or the Orb Cream Puff, the latter because it looks "like the white of egg that has been browned in an oven." (One wonders why the name "Meringue Spider" was not used.) However, the author must have peeped into books long enough to find scientific names for some of her subjects, although a longer look might have enabled her to spell them correctly. Often more than one letter has been omitted, e.g., *Dicta* for *Dictyna*, and sometimes extra letters are added. That these are not merely typographical errors is indicated by the fact that the misspellings are consistent throughout the volume. On one page alone six such errors occur. Names of authors are garbled, as are titles of books, and results are often credited to workers who never did what she asseverates.

As for the illustrations, she may not have *borrowed* any, but some are obviously poor copies of what have appeared in the books she scorns for their inaccuracies. Some are quite definitely not of web spiders at all, and Plate I, showing a spider's internal anatomy (which she admittedly never studied) is a model of distortion. Her original drawings are grossly inaccurate, contain imagined structures, and yet lack even such easily seen details as the correct number of leg segments. Often a drawing will reveal things in contradiction to the text. The arrangement of the illustrations is confusing, with no explanation as to which are "plates" and which "figures," though all are from pen and ink drawings. In many cases illustrations occupying only half or a third of a page (often with text on the same page) are nevertheless called "plates," while full page drawings may be called "figures." On pages 30 and 31 three independent illustrations are labeled "plates 9, 9A, and 9B," while on page 46 appear three independent illustrations over the legend "plates 13 and 14," without any clue as to which is 13, which 14, and which is unnumbered. After seeing the strange illustrations in the book, biologists in general will question the reliability of the author's observations. Many will wonder at her regular use of anthropomorphisms, for she has spiders glaring, showing ecstasy, depravity, and stupidity, being unsportsmanlike, very happy, neurotic, wild with joy, clever, contemptuous, suspicious, high-strung, pig-headed, and lacking foresight. One female "hated the sight of me" and one male "waggled his palps [the genital organs] at me flirtatiously." It is difficult to believe that this volume is in the same series with Humphrey's *Ways of the Weather*, Eberson's *Microbes Militant*, and Luhr's *Physics Tells Why*!

Miss Duncan set aside six months for the study of spiders, but found that more time was needed and so extended her researches into two years. Apparently even this was not long enough for her to learn that males do not possess an epigynum, for which she searched in vain on some specimens. Further, in describing the mating of a pair of *Tetragnatha* she mistakenly assumed that the semen was transferred by the enlarged jaws, and her drawing depicting the act completely omits the all-important palpi. The spinnerets of tarantulas are to her "mysterious horns," and the lung books are "plates . . . which cover the tracheal breathing tubes"!

The final chapter, headed General Facts, contains directions as to the collection, care, and preservation of spiders. Here we find such gems as these: "Never leave a spider in an otherwise empty jar. It will tire itself out"; and "Don't put any water in the bottom. They never drink and will sooner or later drown in it." Her directions for preserving spiders are impractical, and it is small wonder that she was unable to find certain structures on their "bloated and tangled" bodies. Because of this she is vehement in her denunciations of taxonomists who study merely "mouldering corpses on museum shelves."

Why the editor and the publishers saw fit to inflict such a volume on an unsuspecting public is incomprehensible. They would aid the humanizing of science most by suppressing the sale of such a mass of misinformation, especially as it is not unlikely that popular magazines might bring out an extract for the masses. It is to be hoped that no such example of the "blind leading the blind" will occur.

B. J. KASTON

SPHINX. *The Story of a Caterpillar.* *By Robert M. McClung. William Morrow and Company, New York; Wm. Collins Sons & Company, Toronto, Canada.* $2.00. 48 pp.; ill. 1949.

This is a simply written and effectively illustrated

child's book on the development of the sphinx moth from egg to adult. The style and format are in keeping with other excellent nature stories in the Morrow Junior Series.

NORTH AMERICAN WATERFOWL.

By Albert M. Day; sketches by Bob Hines. Stackpole and Heck, New York and Harrisburg. $4.75. xx + 329 pp. + 1 plate; text ill. 1949.

Among the maze of popular bird books that pours out of publishing houses and descends on the reading public there is occasionally one that commands special attention, one that is informative, authoritative, original, and even more rarely, high readable. This is such a book. The reviewer, once started, hardly relinquished it even for such pleasurable pursuits as eating and sleeping. Not many bird books have that effect. It is authoritative because written by the Director of the Fish and Wildlife Service on a subject he is best qualified to discuss, and it is informative because what he has to say is of great importance.

His message is addressed principally to duck hunters, although other sportsmen, conservationists, ornithologists, and anyone interested in wildlife will derive much benefit by reading it. The book starts with a description of early America, the terrific toll on wildlife that occurred with the opening of the West, the slow awakening to the catastrophe that was in store, and the beginning of protective legislation. Since one purpose of this book is to explain the whys and wherefores of governmental regulations, a background of understanding of duck behavior is needed. The description of duck migration and their flyways explains why various regions of the country may have regulations that differ. The work done by the Service in order to estimate duck populations every year is carefully described in order to illustrate how bag limits and closed seasons are determined. The development of the refuge system, its importance to waterfowl, the problems of management, and the value of research are further topics discussed in such a way as to help the layman understand why such things are necessary. In considering waterfowl conservation in Canada it is pointed out how duck hunting in that relatively sparsely inhabited area offers problems that are not the same as those in this country and therefore require different regulations. The so-called "situation" in Mexico is discussed quite frankly. It is shown that the annual kill in that country is less than the kill in the United States on the opening day of the hunting season and that much of the kill south of the border is the result of illegal shooting by Americans. The final chapter points out that the ultimate fate of the wild-fowl depends on the hunters themselves and the attitude they take toward their sport. The regulations at which so many complaints are directed are only a means which without the help and cooperation of sportsmen will not in themselves save the pleasure of hunting wildfowl for future generations. On the jacket is a statement to the effect that this is not an apology from the man in Washington who directs the nation's waterfowl program, but a challenge. It remains for the wildfowling fraternity to read this book and to accept that challenge.

HENRI C. SEIBERT

BIRDS IN YOUR BACK YARD.

By Ted S. Pettit; bird drawings by George Greller; line drawings by Donald Ross. Harper & Brothers, New York. $3.00. xii + 210 pp. + 16 plates; text ill. 1949.

Those who enjoy popular bird books will probably find this one good enough to complete reading it. As the title indicates, the material is limited to backyard ornithology: how to attract and how to feed the birds, how to provide bird baths, and how to photograph them. Since entire books have been written on each of these topics, the present one cannot be considered as a complete reference work; rather, the author's attempt is to point out how bird watching can develop into an absorbing hobby. From reading the text we gather that the writer lives on Long Island; it is too bad that the text was not limited to that neighborhood. According to the jacket advertising its material is applicable from Maine to California and intervening points. To fulfil this broad coverage a chapter entitled What Bird Is That? attempts to describe garden birds over this large geographical area. The result is not very good. The species seem to have been selected without rhyme or reason, and the distinguishing features used for their identification are not aptly brought out. Thus, the sharp-shinned hawk and the Cooper hawk (backyard birds?) have identical descriptions except as to size, which is itself not a reliable field criterion. The list of plantings attractive to birds is better. The book is indexed, illustrated, and contains a short bibliography of books of general interest.

HENRI C. SEIBERT

STUDIES OF THE NESTING BIRDS OF THE EDWIN S. GEORGE RESERVE. PART I. THE VIREOS. *Miscellaneous Publications, Museum of Zoology, University of Michigan, Number 74.*

By George Miksch Sutton. University of Michigan Press, Ann Arbor. $1.00 (paper). 37 pp. + 5 plates. 1949.

Three species of vireos spend the summer on the Edwin S. George Reserve in Michigan. These are the yellow-throated, red-eyed, and warbling vireos. A comparative study of their nesting habits reveals no inter-

specific rivalry. The warbling vireo prefers trees bordering on wet areas and when the water level of a low-lying tract of land rises, this species establishes itself; whereas the red-eyed vireo, which prefers drier oak-hickory woodland, then disappears. The red-eyed vireo is heavily parasitized by the cowbird, whereas the other two species are not. Young males of all three species learn to sing fairly well before leaving for the south. Whether two broods are ever reared under natural circumstances in this area has not been definitely ascertained.

Since the title of this paper bears the notation Part I, we may expect further contributions on the subject. These should add considerably to our information regarding the nesting biology of many species (the most common ones, we hope). The publication contains a color plate of a young yellow-throated vireo just out of the nest, done in water color, and rendered with the delicacy and feeling of a master bird artist.

HENRI C. SEIBERT

THE SANDHILL CRANES. *Bulletin Number 29. By Lawrence H. Walkinshaw. Cranbrook Institute of Science, Bloomfield Hills, Michigan.* $3.50. x + 202 pp. + 18 plates; text ill. 1949.

The sandhill cranes are wild and wary birds, to be seen as they fly away from the approaching observer. Most of our knowledge concerning them has been pieced from fragmentary and disconnected observations. Yet here is an entire book devoted to their life history. To accomplish this feat the author has traveled more than 70,000 miles and spent 15 years studying their habits over their entire range, which spreads from Alaska to the Isle of Pines.

Four geographical races of this species are currently recognized: the lesser sandhill crane, *Grus canadensis canadensis*, which breeds in Alaska and northern Canada; the greater sandhill crane, *G. c. tabida*, breeding in southern British Columbia, Alberta, Saskatchewan, northwestern and northcentral United States east to Michigan; the Florida sandhill crane, *G. c. pratensis*, which breeds along the Gulf Coast, formerly from Louisiana east to Georgia and Florida; and the Cuban sandhill crane, *G. c. nesiotes*, which is found in western Cuba and the Isles of Pines. Size of wing and of tarsi differentiate these races; there is very little difference in plumage coloration. The second chapter discusses this size variation as well as plumage color and molt. The bathing habit of this bird causes its feathers to become dyed by various organic colors in the water. The next chapter considers the characteristic trumpeting calls of the crane, their variations, the notes of the young, the time of day and frequency of utterance. A chapter on crane behavior describes the flight, walking, and swimming activities, as well as the famous dance, which apparently is not limited to the courtship period but may occur at any time. Food and feeding habits are considered next. The cranes prefer grain and vegetable matter such as berries, tubers, etc., but will frequently eat grubs, grasshoppers, frogs, mice and other animals. Evidence for pairing and territory formation is meager, but what little there is indicates that the sandhill cranes remain paired for successive years. Each pair seems to maintain a territory, although its defense is not aggressive, since there is sufficient room available for all. Young birds returning with their parents in the spring are chased away.

A lengthy chapter on nesting includes descriptions of nest sites, clutch sizes, egg sizes, incubation periods, and the geographical and ecological distributions of all four subspecies. It is interesting to note that *G. c. tabida* lays 1.933 eggs per set on the average, whereas *pratensis* lays 1.727, in agreement with the frequently made observation that southern birds lay fewer eggs than their northern congeners. Data on *canadensis* and *nesiotes* are lacking to extend this observation. Nesting success is around 70 per cent. The female incubates during the night and both parents alternate during the day. Hatching dates become increasingly early the farther south the nesting area. Considerable information on the growth and behavior of the young was obtained from a newly hatched bird that was hand-reared by the author and which ultimately became a most fascinating pet.

Both *Grus c. canadensis* and *tabida* are migratory, wintering mostly in California, Arizona, New Mexico, Texas, and northern Mexico; the other two races are resident. A survey of the crane population reveals that *canadensis* is the most numerous, with flocks from 30,000 to 100,000 still being reported. Breeding as it does in northern wilderness areas, its future seems assured. The greater sandhill crane has been greatly reduced in numbers, since its requirements of marsh and solitude have been continually restricted by increasing human population and by cultivation of former marsh lands. Walkinshaw estimates a maximum of 1800 survivors. The Florida race seems on the increase since the creation of reserves in the Okefinokee Swamp and the Everglades. It is impossible to estimate its former abundance, but at present there are about 2650 cranes, including those in Mississippi. The Cuban race is scarce and is given little chance of survival unless adequate protective measures are taken immediately.

The odd bits of information that have just been mentioned are only fragments of the total material assembled in this book. A considerable part of the data is condensed into tables and maps. The literature has been diligently reviewed and frequently quoted. Even pertinent observations on other species of cranes are included. There are 17 plates of photographs showing the cranes, their nests, nest sites, and

a series picturing the growth stages of Brownie, the pet. Appendix A provides a key to the cranes of the world. Appendix B gives complete distribution records for all races of the sandhill crane, including fall and spring migration, and winter records for the migratory forms, listed by state or territory, as well as museum specimens. This extensive record (21 pages) is followed by the bibliography for those records (11 pages). The result is a thorough compendium of existing knowledge on a little known species of bird, a book that will remain an indispensable reference for a long time to come.

HENRI C. SEIBERT

HOMING PIGEONS.

By Herbert S. Zim; illustrated by James Gordon Irving. William Morrow & Company, New York. $2.00. 64 pp.; ill. 1949

This is another of the excellent "animal monographs" by Zim. Older children (and even adults) will find many interesting details regarding the raising and performance of homing pigeons presented in this book. The text is accompanied by many good illustrations drawn by J. G. Irving. It is to be hoped that this will not be the last of this highly informative series of animal stories.

JOHN CUSHING

PENNSYLVANIA BIRDLIFE. *Second Revised and Enlarged Edition.*

By Hal H. Harrison. The Pennsylvania Game Commission, Harrisburg. 50 cents (paper). 72 pp.; ill. 1948.

The Pennsylvania Game Commission is to be congratulated on the appearance of this attractive booklet. Its purpose is to create interest in and to secure help for the protection of birdlife. The following topics are considered: the value of birds; how to attract birds (bird houses, feeding, planting); how to study birds (field observations, banding, photography); conservation of birds (refuges, permits, control); interesting things about birds (a random list of questions and answers plus some bird facts and fallacies); a check-list of Pennsylvania birds; and a thumb-nail sketch of 50 common birds. Since the booklet contains only 71 pages, half of which are taken up by illustrations, it must be obvious that the topics are discussed very briefly. Nevertheless, the aims for which the booklet was published are successfully accomplished; such authoritative propaganda is to be recommended.

HENRI C. SEIBERT

PENNSYLVANIA BIRDS OF PREY.

By Robert D. McDowell and Leo A. Luttringer. Pennsylvania Game Commission, Harrisburg. 25 cents (paper). 33 pp. + 4 plates; text ill. 1948.

If we may borrow from the introduction: "The purpose of this little pamphlet is not to praise or to condemn the birds of prey, nor to further agitate the age-old controversy concerning their good and bad habits. The object is to show people how to identify them and to understand in a general way the part they play in the scheme of nature." To accomplish this purpose, keys to the species of hawks and owls, as well as colored illustrations, are provided for their identification. Each bird of prey is allotted a page for brief remarks on its status and nesting habits. In the corner is a sectorial graph showing clearly the type of food consumed and its proportion to the total diet. Anyone reading this material with an unbiased mind should quickly get the hint that the majority of the birds of prey are more beneficial than harmful. This booklet should be given widespread distribution and made easily available to the public.

HENRI C. SEIBERT

WILD LIFE THE WORLD OVER.

By E. G. Boulenger, A. Radclyffe Dugmore, Walford B. Johnson, Oliver G. Pike, Horace Donisthorpe, F. Martin Duncan, Ray Palmer, Leo Walmsley, and David Seth Smith. Wise & Company, New York. $3.95. 624 pp. + 8 plates; text ill. 1947.

This is quite as fine a natural history of animals as one may find in a single volume. It is distinguished not only for its interesting text, written by a group of well-known naturalists, most of whom are British, but also for its wealth of superb photographs of wild animals. Included, besides the customary groups of mammals, are the chapters A World Survey of Bird Life, Lizards and Snakes, Crocodiles and Other Reptiles, Marvels of the Insect Kingdom, Tiny Creatures of Pond and Stream (protozoa, aquatic insects, frogs and salamanders), Living Fossils of the Sea (sponges, coelenterates, annelids, echinoderms, mollusks, etc.), Fish, their Nature and Habits, and, finally, The March of Evolution. This is an extraordinarily good bargain at the price quoted, and will make a fine gift for any young naturalist.

BENTLEY GLASS

THE FARMER AND WILDLIFE.

By Durward L. Allen. Wildlife Management Institute, Washington, D. C. 30 cents (paper). 84 pp.; ill. 1949.

This attractively printed pamphlet is aimed directly

at the farmer. In non-technical language it persuasively explains why wildlife should be encouraged on the farm, what the farmer can expect from it, and how he can go about making his property attractive by creating brushpiles, fence-rows, field borders, ponds, and other improvements. The principal argument is based on the idea respecting land use that wise and profitable farming goes hand in hand with the presence of wildlife and that only rarely are the two competitive. In accordance with the latest concepts of management, suitable habitat is stressed, with food of secondary importance, and stocking and predator control relegated to the category of the useless. Numerous illustrations of game and habitat improvements, plus some amusing drawings by Oscar Warbach, make this publication an especially well conceived and executed project, one that should do much to spread the good word to the farmers upon whom the major success of wildlife management depends.

HENRI C. SEIBERT

VISON, THE MINK. *American Woodland Tales.*

By John L. George and Jean George. E. P. Dutton & Company, New York. $2.50. 184 pp.; ill. 1949.

Like *Vulpes the Red Fox* (Q.R.B. 24: 59, 1949), *Vison, the Mink* is a fine example of the personalized life story of an animal. From the days of blind kithood in the deeply tunneled den beside the stream to that night, seven years later, when the crafty and battle-scarred veteran swam dauntlessly to his last battle with a younger and now stronger usurper (his own son), Vison's life is portrayed both with realism and poetic feeling. Not the least attractive feature of the book is the wealth of beautiful drawings by Jean George. Here is a perfect gift for the young naturalist of high school age.

BENTLEY GLASS

NATURE AND ITS APPLICATIONS: *Over 200,000 Selected References to Nature Forms and Illustrations of Nature as Used in Every Way. Useful Reference Series, Number 74.*

Compiled by Jessie Croft Ellis. The F. W. Faxon Company, Boston. $17.00. xii + 861 pp. 1949.

This index will be an exceedingly useful tool for those teachers of biology who wish to find references to the more popular articles on subjects of natural history, and particularly to find good illustrations. The extent of the index may be gathered from the fact that even the agouti rates 9 references, while those on the horse, with many subheadings, fill 29 pages. Although some scientific names are indexed, the majority of the terms indexed are common names. The high price of the volume will probably limit it to general libraries, where it is to be hoped it will be universally available.

BENTLEY GLASS

OBSERVATIONS ON THE PLANT COMMUNITIES AT "BUNDEMAR," TRANGIE DISTRICT, NEW SOUTH WALES, IN RELATION TO CHORTOICETES TERMINIFERA (WALK.) AND AUSTROICETES CRUCIATA (SAUSS.). *Council for Scientific and Industrial Research, Commonwealth of Australia. Bulletin Number 236.*

By L. R. Clark. Council for Scientific and Industrial Research, Melbourne. Free upon request (paper). 64 pp. + 5 plates; text ill. 1948.

EVOLUTION

THE MEANING OF EVOLUTION. *A Study of the History of Life and of Its Significance for Man. The Terry Lectures.*

By George Gaylord Simpson. Yale University Press, New Haven; Geoffrey Cumberlege, Oxford University Press, London. $3.75. xvi + 364 pp.; ill. 1949.

These lectures, which throughout show the author's keen feeling for beauty as well as precision of language, fall into three distinct parts. The first section of the book deals with The Course of Evolution. In the brief span of 120 pages, Simpson has given us perhaps the best existing sketch of the geological history of life. For those who found *Tempo and Mode in Evolution* overly technical and difficult, nothing better can be recommended than this outline. The second part of the book deals with The Interpretation of Evolution. Simpson's emphatic disposition of orthogenesis and his discussion of the nature and significance of trends will not surprise any readers of his earlier book, but there are still many students of evolution who need to have the weakness of the evidence for orthogenesis pointed out. Those who still refer to the evolution of the horse, in particular, as a clear-cut example of an orthogenetic trend in evolution ought by all means to be referred to these chapters. Simpson not only stresses the fact that "adaptation has a known mechanism: natural selection acting on the genetics of populations"; he goes much farther in showing that there is no need to postulate intrinsic forces of racial life, senescence, and death, and that evolution is essentially "opportunistic," in the sense that random variations may yield "multiple solutions of adaptational problems." This may be seen on the one hand in the evolutionary appearance of various superficially similar sorts of image-forming eyes, and on the other in the parallels of adaptive radiation seen when "the same sorts of opportunities have occurred for different groups of animals."

The chapter on the Forces of Evolution and their Integration seems to be rather less adequate to its purpose than the others. Perhaps this is because so vast an array of genetic concepts has been compressed here into so small a compass. The treatment is too general and, it would appear, takes too much for understood on the part of the audience. Those who find the treatment obscure may welcome the far more explicit treatment of the genetics of populations given in Chapter II of *Tempo and Mode in Evolution.*

The discussion of The Concept of Progress in Evolution, together with an interesting, if all too brief, historical study of the development of the theory of evolution, provides an excellent transition to the third part of the book, which deals with Evolution, Humanity, and Ethics. Simpson holds that:

"evolution is not invariably accompanied by progress, nor does it really seem to be characterized by progress as an essential feature. Progress has occurred within it but is not of its essence. Aside from the broad tendency for the expansion of life, which is also inconstant, there is no sense in which it can be said that evolution *is* progress. Within the framework of the evolutionary history of life there have been not one but many different sorts of progress. Each sort appears not with one single line or even with one central but branching line throughout the course of evolution, but separately in many different lines. These phenomena seem fully consistent with, and indeed readily explained by, the materialistic theory of evolution sketched in the last chapter. They are certainly inconsistent with the existence of a supernal perfecting principle, with the concept of a goal in evolution, or with the control of evolution by autonomous factors, a vital principle common to all forms of life. . . . To man, evolutionary change in the direction of man *is* progress. . . . It is not progress in a general or objective sense and does not warrant choice of the line of man's ancestry as the central line of evolution as a whole. More general and objective criteria of progress are available and corresponding sorts of progress exist in the history of life. These, too, fail to designate man's ancestry as a central line, and indeed fail to reveal any one such line. A majority of them do, however, show that man is among the highest products of evolution and a balance of them warrants the conclusion that man is, on the whole but not in every single respect, the pinnacle so far of evolutionary progress." (pp. 261–262).

In the search for an ethic, Simpson avoids the fallacy of "nothing but" (an animal) in estimating man's place in nature. "Man," he opines, "is a moral animal." This allows him to search for a basis of ethics, not so much in man's nature as an animal product of evolution, which must lead to a simple survival ethic—"what best promotes survival is good"—but rather in the unique qualities of man as a social being, with "conscious knowledge, purpose, choice, and values [that] carry as an inevitable corollary responsibility." The new evolution, peculiar to man, involves the spread and "inheritance" of knowledge. Seen in this light, authoritarianism and totalitarianism must alike be wrong, while democracy, although wanting in many respects, offers the only ethically good society. Like Hogben (see review of *The New Authoritarianism*, p. 200 of this issue), Simpson would appear to arrive at Muller's conclusion that along with intellectual freedom for all men there must go hand in hand the education and elevation of the standard of living of all men everywhere, so that the heritage of knowledge and power will belong to the many rather than to the few. Simpson puts it this way: "One thing that is definitely known now is that breeding for uniformity of type and for elimination of variability in the human species would be ethically, socially, and genetically bad and would not promote desirable evolution" (p. 335). "We need to remember that cultural evolution proceeds only by interthinking, as organic evolution does by interbreeding. The most brilliant of geniuses is an intellectual eunuch if his knowledge is not disseminated as widely as possible. It is immoral for any man, industry, or nation to reserve knowledge for its own advantage alone" (p. 337). The alternative for our species is self-extinction. For better or worse, man now holds within his hands the possibility of either directing evolution or ending it altogether. Nec temere, nec timide.

BENTLEY GLASS

BIBLIOGRAPHY AND INDEX OF GEOLOGY EXCLUSIVE OF NORTH AMERICA. *Geological Society of America. Volume 13—1948.*

By Marie Siegrist and Eleanor Tatge. Geological Society of America, New York. $3.25. xii + 386 pp. 1949.

Another volume in what continues to be the best serial index of any body of scientific literature. When will we have more of the like, to cover the biological fields?

BENTLEY GLASS

GENETICS AND CYTOLOGY

THE YEAST CELL. *Its Genetics and Cytology.*

By Carl C. Lindegren. Educational Publishers, Saint Louis. $7.00. xviii + 365 pp.; ill. 1949.

C. C. Lindegren is to be commended for a summary of some of the recent developments in studies on the genetics and cytology of yeast. A major portion of the book is devoted to presentations of the author's original publications. In so doing, Lindegren has, to some extent, slighted the very considerable genetic work of the Carlsberg group (Winge, et al.), and the cytological studies of investigators like Subramanian and DeLamater.

Some of the subjects included in the book are: Sporulation and Conjugation, Staining Techniques,

Cytology, Microdissection (of yeast asci), and Regular and Irregular Genetic Ratios in Tetrad Analysis. Techniques in use in the author's laboratory for carrying out genetic investigations with yeast are presented in some detail, and constitute a very valuable part of the book. The author's view of the nuclear cytology of the yeast cell, viz., that the "vacuole" is the "nucleus," is still a subject of controversy in many quarters, and so must be taken with reserve. Lindegren presents data on the irregular segregation of a number of genes, which he feels cannot be reconciled with currently accepted views on genetics. To explain these occurrences, he has proposed the theories of "depletion mutations" and "conversions," the essential feature of which is the transfer of material from gene to gene in the heterozygote. These new theories of Lindegren must await further critical research for substantiation.

There are a number of typographical errors in the text and in the bibliography, and several of the references in the text are not included in the bibliography. There is no subject index. The book is rather specialized for the general biologist, but should be profitable and stimulating to the research worker in genetics.

SEYMOUR POMPER

CELLULA. *Tabulae Biologicae, Volume XIX, Part 3. Edited by H. Handovsky. W. Junk, Den Haag.* Dutch guilders 60.00 ($15.85) (paper). xvi + 316 pp.; ill. 1948.

Largely prepared in 1940, but delayed in publication by the past war, Volume XIX is essentially a compilation in tables of quantitative experimental data in a number of biological fields. The topics covered are as follows: Heat production in different cells (Shapiro); Ermittlung submikroskopischer Strukturen (Frey-Wyssling and Blank); Actions des radiations sur les cellules et les tissus (Dognon and Biancani); Cell metabolism (Krebs and Johnson); Constantes physico-chimiques des colorants, utilisés dans l'étude des cellules (Lison and Fautrez); and Vergleichende Chemie pflanzlicher Zellen (Froeschel). Much of the information, with the exception of that by Frey-Wyssling and Blank, dates before 1940, and is consequently, in some instances, outmoded by more recent findings. The specialized worker in these fields, however, will find the tabulated material quite useful.

C. P. SWANSON

HYBRID CORN (MAIZE) IN THEORY AND PRACTICE. *By Gordon Haskell. The Biological Press, London.* 5s. or $1.00 (paper). 23 pp. 1949.

The United States is the only nation of the world which has fully explored the enormous possibilities of hybrid corn as an agricultural product, despite the fact that its proved worth has been known for some fifteen years. Other nations, however, are becoming aware that hybrid corn offers a partial solution to the ever-present food problem, and in England steps are being taken to obtain inbred lines which can be satisfactorily crossed for improved yields. The author is associated with this project, and in this brief address to the British Association for the Advancement of Science he outlined the history and methods of hybrid corn production, discussed the basis of heterosis, and considered the possible value of a breeding program for the British Commonwealth. It is a concisely written but informative pamphlet.

C. P. SWANSON

GENETICS OF THE FOWL. *McGraw-Hill Publications in the Agricultural Sciences. By F. B. Hutt. McGraw-Hill Book Company, New York, Toronto, and London.* $6.50. xii + 590 pp.; ill. 1949.

A book such as the present one has been long overdue. Much of the literature on poultry genetics has been published in journals and bulletins which are not easily accessible, and all too little effort has been made by many authors to give critical reviews of the work done by their predecessors. Hutt's book is primarily designed to meet the needs of courses on poultry genetics and to provide other geneticists and biologists generally with a critical digest of the available information. It may be said at the outset that both purposes have been met admirably.

The 15 chapters of the book deal with the following subjects: the phylogeny and origin of breeds; cytology; variations in the skeleton; structural variations of the skin; structure, distribution and growth of feathers, and hen feathering; skin color; plumage color; lethal genes; variations in body size; egg production; variations of eggs in size, shape, structure and composition; disease resistance; reproductive factors, such as fertility, embryonic mortality, sex ratio, sex dimorphism, sex reversal, and mosaics; linkage groups; aspects of practical poultry breeding. The book closes with a list of symbols of the genes of fowls, a glossary of genetical terminology, and satisfactory indices.

The developmental and physiological aspects of hereditary traits are briefly discussed in each instance, and the interested reader will find in the bibliographies of each chapter an excellent guide to the pertinent literature. It seems to the reviewer that the chapters on reproductive factors are especially satisfactory because here the author has succeeded, without going into controversies over the many over-optimistic and unjustified claims abounding in the literature, in giving an exceptionally clear account of what is known beyond dispute.

A comparison of Hutt's book with Punnett's *Heredity in Poultry* (1923) shows that not a little has been accomplished in the intervening quarter century. Yet, in a wider sense, the present book should serve as a very strong indictment of the lack of sympathy, understanding, and support which, chiefly on the part of our Agricultural Experiment Stations, is responsible for the deplorably slow rate of progress of genetic studies with fowl. One may entertain the scant hope that, beyond its immediate purposes, Hutt's book will contribute to a more general understanding of the inexcusably wide and apparently ever widening gap separating "theoretical" and "applied" genetics.

WALTER LANDAUER

LEBER'S DISEASE. *A Genealogic, Genetic and Clinical Study of 101 Cases of Retrobulbar Optic Neuritis in 20 Danish Families. Opera Ex Domo Biologiae Hereditariae Humanae Universitatis Hafniensis. Volume 10.*

By Ruth Lundsgaard. Gyldendalske Boghandel, Copenhagen; Ejnar Munksgaard, Copenhagen. Kr. 25.00 (paper). 306 pp.; ill. 1947.

Leber's disease is an uncomplicated bilateral retrobulbar neuritis appearing predominantly (85%) in males after puberty and culminating in the course of some weeks or months in a stationary loss of central vision and optic nerve atrophy. Peripheral vision is retained, so that complete blindness does not ensue. The disease is definitely inherited, and early authors were led, because of the great excess of affected males, to postulate sex-linkage. However, the fact that about 16% of those affected are females, and the fact that with a few questionable exceptions an affected male has not been known to transmit the disease to his grandsons have led some investigators to various modifications of the theory of the sex-linked inheritance of the disease, whereas others have proposed theories based on autosomal or even cytoplasmic inheritance.

Lundsgaard, in another of the studies sponsored by the Institute of Human Genetics of Copenhagen University, has undertaken an extensive clinical and genetic investigation of all the cases of Leber's disease occurring in recent years in Denmark. A particular effort has been made to trace possible relationships between the various Danish families in which the disease has been reported. This has involved extensive recourse to various public and medical records. From these efforts there have resulted 20 pedigrees, several quite extensive, plus 5 isolated cases. The author is to be complimented on the completeness of her genealogical studies. The pertinent clinical data on the diagnosis and course of the disease, and the findings of previous investigators, are also treated in detail.

Lundsgaard's data reveal the usual marked excess of affected males. She finds that nowhere in her data or in those pedigrees which she is willing to accept from the literature is there any evidence that an affected male has transmitted the condition to his grandsons, an essential prerequisite of sex-linked inheritance. She postulates, therefore, that the disease is due to an autosomal gene with complete or nearly complete dominance in the male but very incomplete dominance in the female, with the further condition that the gene is lethal to all spermatozoa which receive it. A somewhat similar theory was proposed by Komai in 1934.

This genetically complex and ingenious hypothesis merits careful scrutiny. It appears to provide a formal explanation for the observed facts. The author's own crucial data are derived from a single extensive family, summarized in Pedigree A. It is stated that of 7 grandsons of certainly affected males, and 4 of probably affected males, none developed Leber's disease. It is unfortunate that these critical lines of descent are not clearly indicated on the pedigree in question, nor was the reviewer able to find data on the age of the unaffected grandsons—an extremely important point when one is concerned with a disease so variable in its age of onset. Certain confirmatory data are cited from the literature, but part of these appear open to the same criticism regarding the age of the unaffected grandsons. The reviewer does not mean to imply that the point is invalid, but rather that it is not possible from the presentation to form an objective opinion as to the degree of validity. An unrelated objection to this hypothesis, of an entirely theoretical nature, is the fact that there is little evidence from the extensive investigations of infra-human material that genes contained in spermatozoa are physiologically active. Although there are bound to be exceptions to this rule, the fact remains that they must be uncommon.

The author's conclusions would be strengthened by further data relating to the above-discussed grandsons. It is greatly to be hoped that follow-up studies will be carried out and that the results will be added to these extensive pedigrees. Even without this addition, however, the monograph must be accounted a very significant contribution to a complex problem in human inheritance.

JAMES V. NEEL

HEREDITY IN HUMAN LEUKEMIA AND ITS RELATION TO CANCER. *A Genetic and Clinical Study of 209 Probands. Opera Ex Domo Biologiae Hereditariae Humanae Universitatis Hafniensis. Volume 13.*

By Aage Videbaek. Arnold Busck and Ejnar Munksgaard, Copenhagen; H. K. Lewis, London. Kr. 15.00 (paper). 279 pp.; ill. 1947.

The author reports the results of an extensive study on heredity in human leukemia, together with a review of the available literature on the subject. The starting point for the investigation was a material of

310 persons for whom a diagnosis of leukemia had been made between the years 1936 and 1945 in the greater Copenhagen (Denmark) area. It was possible to obtain accurate data on the family histories of a representative group of 209 of these individuals. The control material consisted of 200 normal persons. For both the control and the leukemic groups, an attempt was made to determine the morbidity of leukemia and other forms of cancer in parents, grandparents, paternal and maternal uncles and aunts, brothers, sisters, and children. There were 4041 relatives in these categories for the leukemia material, and 3641 for the controls. Seventeen of the leukemic patients were found to have some relative with leukemia, yielding a minimum "familial incidence" of 8.1 per cent; only one case of leukemia was discovered among the relatives of the controls. The familial cases followed no simple genetic pattern. There was no apparent tendency for the same type of leukemia (myelogenous, lymphocytic, acute or stem-cell) to occur within a family in which there were multiple cases. The author concludes, therefore, that from the genetic standpoint the three above mentioned types of leukemia may be considered as a single entity, with the tendency to develop the disease depending on "chromosomal inheritance," possible "failing dominance," possibly "polymeria." There is some evidence to suggest that all forms of the disease are diagnosed earlier in families in which there are multiple cases than in families in which the case is an isolated occurrence. One or more cases of pernicious anemia were observed in 17 of the 209 families for which the proband was a person with leukemia, but in only 6 of the 200 control families, from which it is concluded that there is a significant tendency for leukemia and pernicious anemia to be associated in the same family. Diabetes, hyperthyroidism, and hypothyroidism did not have any higher incidence in leukemic individuals and their relatives than in the control material.

Among the 4041 relatives of the 209 leukemic patients, the diagnosis of cancer had been made in 319, while among the 3641 relatives of the control probands there were 218 diagnoses of cancer, the difference being significant and present in all categories of relatives. The increased cancer incidence among the relatives of leukemics did not appear to be restricted to any particular type of cancer. It is stated that the cancer risk—"the probability of the relative in question getting cancer if he lives through all the age classes in which it is possible to get cancer"—is the same for all types of leukemia, varying from 23 per cent in paternal aunts to 48 per cent in fathers, with an average of 31 per cent, whereas in the control material the average is 21 per cent. It is felt that the data suggest that there is a dominant gene common for all the different forms of cancer. The author postulates that the development of leukemia in any individual depends on a variety of factors, including a non-specific hereditary predisposition to cancer, which is believed to be present in at least 20 per cent of the population, and the presence of one or several genes, the activity of which plays a role in the localization of cancer to the leukon.

The data which the author presents are extensive and apparently of high validity. His case for an increased familial incidence of leukemia and other forms of cancer among the relatives of leukemics appears sound. The reviewer's only reservation concerns the inevitable question of the strict comparability of the control material; no significant discrepancies are readily apparent. The promulgation of a precise genetic theory to account for the observed facts may impress some as premature, yet to the extent that this serves as a point of departure for further discussion and investigation it performs a valuable service, regardless of the final verdict concerning its validity.

JAMES V. NEEL

DICTIONARY OF GENETICS *Including Terms Used in Cytology, Animal Breeding and Evolution. Lotsya—A Biological Miscellany, Volume 2.*

Compiled by R. L. Knight. Chronica Botanica Company, Waltham, Mass.; Stechert-Hafner, New York. $4.50. xii + 183 pp. 1948.

The production of this dictionary of genetics was a vast labor which all biologists will surely, in spite of its minor faults, regard as wholly praiseworthy. To quibble over a few faulty definitions, most of which, like the definition of "orthoploid," are simply too narrow in failing to indicate all the current uses of the term, would be grossly unfair. It should be a personal obligation of every geneticist and cytologist to refer to the author suggestions for the correction and improvement of the definitions given and for the inclusion of other terms. To Knight himself we can only render gratitude for doing what many would regard as a thankless task, but which all will recognize as a most valuable contribution, now that it has been made. Among the useful features of the book are its several appendices, which contain such information as useful statistical formulae, coefficients of the expansion of $(1 + x)^n$ from 1 to 20, values of 2^n and 4^n for values of n from 3 to 20, a table of χ^2, genotypes expected in backcrosses and in F_2, percentages of homozygotes following selfing up to F_{12}, the rate of elimination of a donor genotype by backcrossing, and the International Rules for Symbolizing Genes and Chromosome Aberrations, etc.

BENTLEY GLASS

GENERAL AND SYSTEMATIC BOTANY

INTERNATIONAL RULES OF BOTANICAL NOMENCLATURE. *Formulated by the International Botanical Congresses of*

Vienna, 1905, Brussels, 1910, and Cambridge, 1930; Adopted and Revised by the International Botanical Congress of Amsterdam, 1935. Unofficial Special Edition Issued as a Service to Members of the American Society of Plant Taxonomists. Brittonia, Volume 6, Number 1, 1947.

Compiled from various sources by W. H. Camp, H. W. Rickett and C. A. Weatherby. The Chronica Botanica Company, Waltham, Massachusetts. $3.50. Pp. 1–120. 1948.

In March 1946, at a meeting of the council of the American Society of Plant Taxonomists, a committee on nomenclature was formed to begin preparing agenda for the next International Botanical Congress. It soon became clear that before this could be done, it would be necessary to prepare a clear statement of the existing international rules of botanical nomenclature. Copies of the last edition of these rules (1935) were no longer available, and emendations to them made later in 1935 were not readily available to many American students. The committee, therefore, has compiled the existing rules in a single volume, which they say is not to be regarded in any sense as an official edition, although it is taken from authentic sources. As appendices they have included lists of *nomina conservanda* and an index to the plant names appearing in the lists of conserved generic names. The book ends with a general index.

Originally published in *Brittonia*, the publication now appears in a "second printing," reproduced by offset lithography. To institutions and individuals concerned with taxonomic research, it will be a valuable tool.

H. M. RAUP

THE ESSENTIALS OF PLANT BIOLOGY.

By Frank D. Kern. Harper and Brothers Publishers, New York and London. $4.00. viii + 440 pp. + 6 plates; text ill. 1947.

The subject matter in this elementary textbook has been divided into two major categories: the maintenance of individual life, and racial preservation. When it is considered that these two rather inclusive topics are encompassed in a book designed for a one-semester course in botany, it is readily understandable that no single phase of the science can receive other than a most cursory treatment. The chapter on plant anatomy is probably the most completely written and illustrated. Nutrition and physiology are presented in a most elementary fashion, e.g., only three very simple chemical reactions are presented. Meiosis is considered in a page and a half plus one incorrect diagram, although the author stresses the fact that "the whole process of meiosis must be understood because it affords the basis of the genetic phenomena to be discussed later." Crossing over is disposed of by the statement that "it is reported that linkage is not perfect."

The book, therefore, although well written and illustrated, can scarcely be considered the equal of other similar volumes. It can be recommended, however, for those students who must take a required course in the natural sciences—it will not overtax them.

C. P. SWANSON

STUDIES IN PLANT LIFE. *Second Edition.*

By Harvey E. Stork. Burgess Publishing Company, Minneapolis. $3.00 (paper). vii + 115 pp.; ill. 1949.

LABORATORY EXERCISES; BIOLOGY OF PLANTS.

By H. L. Dean. Wm. C. Brown Company, Dubuque, Iowa. $2.25 (paper). vi + 265 pp.; ill. 1949.

LABORATORY AND FIELD EXERCISES IN BOTANY.

By Fred W. Emerson and Lora Mangum Shields. The Blakiston Company, Philadelphia and Toronto. $2.50 (paper). xii + 303 pp.; ill. 1949.

WORKBOOK IN FUNDAMENTALS OF PLANT SCIENCE.

By George B. Cummins and George A. Gries. Burgess Publishing Company, Minneapolis. $2.00 (paper). iv + 121 pp.; ill. 1948.

LABORATORY PROBLEMS IN PLANT SCIENCE.

By George B. Cummins, George A. Gries, Jesse H. Lefforge and Forest W. Stearns. Burgess Publishing Company, Minneapolis. $2.00 (paper). iv + 112 pp.; ill. 1948.

Prepared laboratory manuals in botany can be had for almost any type of course. Most are designed to meet the needs of particular courses given by their authors, but the requirements of almost any beginning botany course can be met by one or another of the many manuals currently available. The current crop reflects this diversity. Those by Stork and Dean, respectively, are semi-textbooks, on the whole well written and reasonably illustrated. The manual by Emerson and Shields is a laboratory accompaniment to Emerson's excellent *Basic Botany*. That by Cummins and Gries is particularly poor, and any resemblance between their drawings and actual plant materials is pure coincidence.

Laboratory manuals are obvious time-savers for both students and teachers, but one is led to wonder whether a student acquires what he should from this sort of teaching device. Rapidity of training is fast becoming a goal in itself, and the encouragement of curiosity seems noticeably missing. There can be little doubt that part of the lack of enthusiasm for botany among students stems from the mechanical introduction to the science which these manuals represent.

C. P. SWANSON

CONTRIBUTIONS DE L'INSTITUT BOTANIQUE DE L'UNIVERSITÉ DE MONTRÉAL. *Nouvelles Études Taxonomiques sur la Flore de Cuba. Number 63.*

By Frère Marie-Victorin. Université de Montréal, Institut Botanique, Montréal. 50 cents (paper). 77 pp.; ill. 1948.

This contribution consists of six posthumous papers prepared by Frère Marie-Victorin before his death in 1944. They are additional material to Contribution No. 49, published in 1944 by Frère Marie-Victorin and Frère Léon of Havana. The present volume has an explanatory foreword by Jules Brunel. Nineteen new entities are described, consisting of 15 new species and 4 new varieties. First is a review of the genus *Hedyosmum*, with a key to the species and a description of 1 new species, *H. leonis*. The second paper is a treatment of the genus *Belotia* in Cuba, and contains one nomenclatural change; *B. lessertiana* Hochr. is reduced to a variety of *B. grewiaefolia*. The third paper is a revision of the genus *Spathelia*, with a description of 5 new species and 1 new variety. The genus *Purdiaea* is revised in the fourth paper with descriptions of 4 new species and 3 new varieties. The remaining two papers treat the genus *Ravenia*, with 3 new species, and contain a description of a new species of *Sabbatia*. The papers are amply illustrated with photographs.

H. M. RAUP

CONTRIBUTIONS DE L'INSTITUT BOTANIQUE DE L'UNIVERSITÉ DE MONTRÉAL. *Number 64, March 31, 1949.*

Institut Botanique, Université de Montréal, Montréal. 50 cents (paper). 83 pp.; ill. 1949.

Contribution 64 consists of seven papers, all concerned primarily with taxonomic and floristic studies in eastern Canada. The following is a list of the contents: The rediscovery of the Desmid *Pleurotaenium spinulosum*, with description of a new variety from Madagascar (Jules Brunel); *Achroonema spiroideum* Skuja 1948, of the Trichobacteriales, discovered simultaneously in Sweden and in Canada (J. Brunel); Le genre *Elatine* dans le Québec (Roger Gauthier and Marcel Raymond); Notes sur le genre *Carex*. II. La valeur taxonomique de *C. arctogena* (M. Raymond); Notes sur les *Arisaema* du Québec, (M. Raymond); Quelques Muscinées des iles de la Madeleine, (James Kucyniak); Enumeratic plantarum vascularum Terrae Novae, (Ernest Rouleau).

H. M. RAUP

ATLAS POUR LA DÉTERMINATION DES DIATOMÉES.

By P. Lefèbure. Laboratoire de Micrographie, Paris. 300 fr. (paper). 80 pp.; ill. 1947.

Thirty-one plates illustrating and identifying diatoms, with a table of genera but no keys.

THE ALGAL GENUS GRACILARIA IN AUSTRALIA. *Division of Fisheries—Report Number 15. Council for Scientific and Industrial Research, Bulletin Number 235.*

By Valerie May. Council for Scientific and Industrial Research, Melbourne. Free upon request (paper). 64 pp. + 15 plates; text ill. 1948.

A taxonomic study of the 9 species of the genus *Gracilaria*, most used in Australia for agar production Six new forms are described.

NATURAL HISTORY OF THE DANISH LICHENS. *Original Investigations Based Upon New Principles. Part I–VII.*

By Olaf Galløe. (I–IV) H. Aschehoug & Co., Copenhagen; (V–VII) Einar Munksgaard, Copenhagen. Dan. Kr. 40.00 each (paper). (I) 93 pp. + 160 plates. 1927; (II) 84 pp. + 128 plates. 1929; (III) 114 pp. + 127 plates. 1932; (IV) 81 pp. + 133 plates. 1932; (V) 117 pp. + 140 plates. 1936; (VI) 103 pp. + 88 plates. 1939; (VII) 62 pp. + 101 plates. 1948.

Lichenologists, particularly the English-speaking group, should consider themselves fortunate in having available the seven completed parts of this proposed 10-volume work. The 592 pages of English text are supplemented by 2,977 black and white drawings water colors, and some color photographs on 776 plates. The quality of the paper, the large type, and the beautifully reproduced illustrations reflect well the generosity of the Carlsberg Foundation, which has sponsored Galløe's studies. The last two volumes will consist of a general survey of the taxonomy and natural history of Danish lichens; an index to genera and species would make the material more readily available.

Although the title would imply a local survey of Danish lichens, the treatment itself considers genera and species having a wide, north temperate distribution; hence the work has a more general application. The style is monographic, although the author does not cite synonymy; he admits that much of the basis for his species conception is contained in Th. Fries' *Lichenographia Scandinavica*. The handling of some 60 genera and numerous species is also unique in that the author presents a detailed morphological and anatomical analysis of "typical, selected and representative" individual specimens to give a concept of the particular species instead of conventionally citing types. Thus, *Lobaria pulmonaria* is given with detailed description and drawings of six specimens. He suggests this as a means of gaining a better conception of a species in the absence of type material. Galløe's early suggestion, in Volume One, for the development of an International Institute for type specimens would not be too willingly accepted by most taxonomists with our present-day realization of what has happened

to the plant collections stored in bombed-out European cities.

With each genus Gallœ gives a statement of the phylogeny. Species treatment consists of a full, expert description supplemented by numerous detailed illustrations of the internal thallus anatomy, apothecia, spores, and gross morphological features, of which one can only quote the late Lynge's critical remark:—"Gallœ's figures are excellent as they always are." With the exception of a local citation, no floristic data are presented, for, as the author clearly states, this is not a floristic study but a natural history survey. Neither are chemical reactions given, for the author rightfully considers the interpretation of these reactions as 'disputable'." To students in lichenology, to cryptogamic botanists with little knowledge of lichens, and to the non-professional botanist, the natural history of the Danish lichens makes available a wealth of information to those seeking definite answers regarding the morphology of lichen genera; it will serve admirably for the identification of species or as an introduction to the interesting science of lichenology. This is an excellent treatment of a generally ignored branch of cryptogamic botany.

GEORGE A. LLANO

LES CHAMPIGNONS. *Tableaux d'un Monde Étrange. By Roger Heim; photographs by Jean Vincent; illustrations by Yvonne Jean-Haffen. Éditions Alpina, Paris.* 2200 fr. (paper). 143 pp. + 6 plates; text ill. 1948.

This book appears to be intended for those intelligent persons who lack a special training in mycology but who are, or may be led to become, interested in the fungi which lie before them wherever they may go. The author indicates that the subject of mycology may be at the same time a sport, a science, and an art. The proper study of fungi involves personal visits to their natural habitats, learning where and when to find them and, having learned to know them, the faculty of remembering what they are and for what reasons they are of special interest. Heim gives careful advice which, if followed, will aid the would-be mycophagist to find and recognize dangerous species first and then gradually the safe ones, beginning with those most easily detected and distinguished from the poisonous sorts, and then proceeding to the recognition of most of the fungi that may be made use of. Translating from the author: "Once the worst species are known, the mycophagist will penetrate gradually among those which merit his confidence for the kitchen. He will approach them with prudence, with method, progressively, commencing not with the best but with those which one can characterize best in a limited category. He will reject all those eminently dangerous rules of thumb which are current in the country and elsewhere: the piece of silver that blackens, the onion that turns brown, the flesh that becomes blue, etc." He criticizes the difficulties caused in most books by too technical an approach to the subject, as well as by the reluctance of the masters of the subject to give their time and effort to write about it accurately but in words that the layman can comprehend.

The main chapters are: The Fungi of April, *Russula* and *Lactarius*; From the Clavarias to the Polypores; The Boleti; The Fungi Which Gleam (including a brief discussion of luminous fungi as well as those which shine when their viscid coat becomes wet by rain or dew; The Agarics; The Gasteromycetes; The Destroyers (fungi injurious to plants); Insects and Fungi; A Visit to the Laboratory (to see fungi under culture); The Healers (antibiotics); and finally, an Invitation for a Field Trip. This part is followed by a Summary Table of the general classification of fungi and by a Key for determining the European genera of Gill Fungi, and a Key to the European genera of Basidiomycetes growing on dead or dying wood (mostly the Heterobasideae and Aphyllophorales). Each chapter presents a short general discussion and then is illustrated by marvelous photographs of the more important species, each with a description in non-technical terms of their most distinctive characters. Notes are given as to their safety or danger when eaten. Such notes, however, are not always given in these separate descriptions, but are included in the general text or even in the introductory chapter. In criticism, the reviewer wishes that a list had been given of all the species illustrated, with emphasis on their safety or danger as food. The six colored plates are from water-color sketches which lack the finer details but show well the forms and colors.

In this book, intended mainly for the general public, the author does not indulge in the extensive genus-splitting that is now becoming the style among some modern mycologists, but gives the older, more familiar names. Each species illustrated is discussed under its French name, although the Latin name (without author citation) is given for each uncolored figure. The size of the book (10 × 9 inches) and its paper binding will prevent its being used extensively for field trips, but its careful perusal can not fail to stimulate and help intelligent persons who read it before and after making such trips. Although intended primarily for France and adjacent regions, the fact that most of the species illustrated occur even in America will make the book well worth possessing in this country.

ERNST A. BESSEY

POISONOUS FUNGI. *The King Penguin Books. By John Ramsbottom; with colour plates by Rose Ellenby. Penguin Books, London and New York.* $1.00. 32 pp. + 16 plates. 1945.

This compact little volume successfully maintains the standards which have characterized the other King Penguin books covering technical fields. The typography and general format of the book are excellent. The 16 pages of colored plates are in general accurate and effective, embellishing as well as supporting the compact text. The board covers, with conventional mushroom figures in a repeat pattern, are in colors sufficiently lurid and warning to give at once a subjective impression of poisonous qualities.

The general part of the text, in the brief space of 14 pages, covers the historical background of the recognition of poisonous mushrooms, gives the necessary definitions and derivations of terminology, and does a helpful service in pointing out the futility of the popular and superstitious criteria for distinguishing poisonous forms and emphasizing the need for the study of the essential features on which trustworthy recognition depends. Attractively written, this introductory general treatment is enlivened with the deftly whimsical and amusing touches for which the author is well-known.

The descriptive and more technical part of the text (16 pages), characterizes the important poisonous genera, emphasizes the several species of *Amanita* that are notably deadly, and briefly and effectively describes the poisonous species of lesser importance in 11 other genera, especially *Lepiota*, *Lactarius*, *Russula*, and *Entoloma*. Since practically all of the species discussed occur in this country as well as in Great Britain, the book will be of equal value here, although the illustration of *Amanita muscaria*, as shown in color plate 4, has the deeper red cap typical of the European form, less typical of those found in this country.

WILLIAM H. WESTON

HENRICI'S MOLDS, YEASTS, AND ACTINOMYCETES: *A Handbook for Students of Bacteriology. Second Edition. By Charles E. Skinner, Chester W. Emmons, and Henry M. Tsuchiya. John Wiley & Sons, New York; Chapman & Hall, London.* $5.00. xiv + 409 pp.; ill. 1947.

This second edition will receive an enthusiastic welcome, not only from those already familiar with the valuable and useful first edition of 1930, but also from many additional readers who will learn how effectively this meets their needs and will appreciate the farsightedness of Henrici, who foresaw these needs many years ago. The present authors, Skinner, Emmons, and Tsuchiya, undertook the rewriting of the book largely out of regard for Dr. Henrici, whose failing health halted his own revision. Consequently, they have adhered closely to the spirit which motivated the original edition, namely, to present for the bacteriologist an effective discussion of molds, yeasts, and actinomycetes, together with a working knowledge of pertinent aspects of mycology which will greatly enhance his effectiveness in his own field. Toward this end the emphasis on the medical and industrial applications of mycology has been extended and intensified, and a sound working knowledge of the morphology of the fungi, their classification, cytology, genetics, life cycles, and development has been made available, so that the bacteriologist may more effectively understand such comparable aspects of his own field as the structure and development of bacteria and especially their variation and cycles of development.

The present volume has been notably extended, comprising 409 pages in contrast with the 296 of the first edition. Not only has the material been carefully reorganized, thoroughly revised, and extensively rewritten, but much that is recent, significant, and valuable has also been added. The second chapter, on Variations in the Lower Fungi, is a new one, and the only one prepared in full by Henrici himself; Chapter 14, on Antibiotic Substances, by Tsuchiya is new; and the revision and expansion by Emmons of the material dealing with Fungus Diseases of Man and Animals and with Infections Caused by Molds have contributed a large proportion of new subject matter to Chapters 6 and 7. The total number of chapters, therefore, is now 14 in contrast with the 11 of the first edition. In rewriting the book the three collaborators have cooperated effectively, each dealing with that area in which he was especially expert. In general, Skinner has carried out the revision of the chapters (I, III, IV, V, IX, and XII) concerned with general mycological matters; Emmons has covered the medical mycology (chaps. VI, VII, X, XIII); and Tsuchiya has handled nutrition, fermentation, antibiotic action, degradation, and other biologic activities (Chaps. VIII, XI, and XIV).

The total number of figures has been increased to 136, and while most of the 100 figures of the early edition have been retained, some that are more effective have been substituted and many new ones have been added. A number of valuable new tables has been added, especially in the chapters on the biological activities of molds. The lists of references to pertinent literature, usefully expanded and brought up to date, appear at the end of each chapter, except in the case of Chapter 7, in which instance the references dealing with the several infections caused by molds occur at the end of each section, being proportionately extensive after the full discussion of diseases such as coccidioidomycosis, the dermatophytoses, the blastomycoses and others, and less extensive after the briefer sections on diseases such as aspergillosis and mycetoma.

The chapter on variations in the lower fungi is a helpful addition that will contribute toward enlightening the bacteriologist on the vagaries of fungous behavior. The chapter on methods has been amplified to 30 pages, twice the length of the original, with num-

erous and recent literature references. The new material in this chapter includes additional information on special media and on the techniques for culturing, isolating, and examining the pathogenic fungi.

The discussion of the phycomycetous molds (chap. 4) has been condensed in revision, chiefly by the wise omission of the key to the species of *Mucor*, which occupied 4½ pages in the first edition; and some additional material has been included. The chapter on the molds of the Fungi Imperfecti and Ascomycetes (chap. 5) considers the Penicillia and Aspergilli in some detail, as befits the extensions since 1930 of our knowledge of these two important genera and, wisely omitting the key to the groups of species of *Aspergillus*, gives the readers a sound understanding of the requirements and taxonomic basis for identification and then refers him to the recent, complete, and authoritative *Manual of the Aspergilli* by Thom and Raper. This chapter also gives brief discussion of the chief characteristics of the more common molds which have especial interest and are likely to be encountered by the bacteriologist.

In conformity with the emphasis on the medical aspects of mycology, the four chapters concerned with the general aspects of the fungous diseases of man and animals, the infections caused by molds, the pathogenic yeast-like fungi, and the actinomycoses have been rewritten and expanded so that they add notably to the strength of the book. In this treatment of medical mycology considerable new material has been added, obsolete passages have been omitted, the nomenclature has been simplified and brought up to date, and the discussions of toxins and of the biochemical activities of the pathogens have been effectively expanded.

The chapters dealing with the biological activities of molds and yeasts and the industrial applications of these activities have been considerably expanded also. Fairly detailed accounts of the biochemical reactions involved are included, especially in the sections dealing with citric, gluconic, and other acid fermentations by molds and the alcoholic fermentation by yeasts. In addition, several new tables list the acids, pigments, and other metabolic products with their formulae, noting the organisms producing the products and, in some instances, including in the table the essential references to the sources of information.

The treatment of the structure and classification of the yeasts and yeast-like fungi, although covering in one chapter the material formerly given in two, has successfully achieved this condensation by a rewriting which effectively encompasses the notable advances in this field since the first edition was published. Similarly, the chapter on the actinomycetes presents an able treatment of the long established and the recently contributed material in this area.

The chapter on antibiotics, however, is somewhat disappointing, and is certainly not comparable to the rest of the book in effectiveness and adequacy of treatment. Also, although the illustrations as a whole are excellent, a few, such as Fig. 31 of *Pythium* and Fig. 70 of *Monascus*, are rather below the standards of the others.

The present book, even more than the first edition, fulfils Henrici's original purpose of filling the gap between the relatively ineffectual treatments of mycology in some bacteriological textbooks and the extensive technical mycological treatises with their detailed discussions of the fungi from the botanical, classificational, or plant pathological points of view. The three collaborating authors are to be congratulated on producing a book which not only attains the worthy objectives and maintains the high standards of Henrici, but also achieves a utility that will render it of great value to microbiologists, mycologists, and others in fields far removed from the bacteriologists to whose service it originally was dedicated.

WILLIAM H. WESTON

WILD FLOWERS IN THE ROCKIES.

By George A. Hardy and Winifred V. Hardy; illustrated by Frank L. Beebe. H. R. Larson Publishing Company, Hamilton, Saskatoon, and Vancouver. $7.50. 125 pp.; ill. 1949.

In an artistic sense, this slender volume is in a class by itself. Its excuse for being is primarily to provide a medium of expression for the illustrator, Frank L. Beebe, and its proper place is a choice spot in the flower-lover's library. The 50 colored plates, each being made up of four species, are superbly reproduced on excellent paper, and their composition and accuracy of detail are ample evidence that Beebe is a competent naturalist as well as a first-rate artist. This is not a field botany book, however, despite its title. The accompanying descriptions are appreciative in tone rather than taxonomical; and the species depicted, while representative, include but a small number of the floral members of the Canadian Rockies. A grouping of the species by color, and secondarily by family, will enable one readily to track down any one of the 200 species included, and will thus satisfy those whose interest is confined to the more conspicuous flowers; but the availability of more inclusive field books and the rather prohibitive price of the volume will weigh against its general acceptance. On the other hand, the book is an excellent example of what can be done for a popular subject through close cooperation of illustrator and authors.

C. P. SWANSON

SHRUBS OF MICHIGAN. *Bulletin Number 20, Second Edition.*

By Cecil Billington. Cranbrook Institute of Science,

Bloomfield Hills, Michigan. $4.50. viii + 339 pp. + 3 plates; text ill. 1949.

It is rare that a book on taxonomy passes through a second edition in six years. A second printing usually suffices. The author, however, has felt, and with good reason, that since the nomenclature of the first edition conformed with that of Gray's *Manual* of 1908, a second edition was warranted in the light of changes which have been made since that time. The inclusion of many new shrubs, previously excluded or unknown in Michigan, also serves to give a more comprehensive treatment of the shrub flora of the state. To those readers who are not familiar with the first edition, this is a volume by an amateur botanist who writes for the amateur. The clarity of its descriptions and illustrations, however, would bring credit to a professional scientist, and the author and the Cranbrook Institute of Science are to be commended for an exceptionally well done and readable book.

C. P. SWANSON

THE SHORTER BRITISH FLORA.

By C. T. Prime and R. J. Deacock; illustrated by A. Swaffer and A. I. Charlton. Methuen and Company, London. 12s. 6d. xl + 376 pp.; ill. 1948.

This is a small manual for the identification of about 720 species of the commoner British plants. The rarer species have been omitted. There is a brief introduction on how to use the book and a partially illustrated glossary. These are followed by a key to the families. The order of treatment is in general that of the Bentham and Hooker system. For each family there is a brief general description, a key to the common genera and species, and notes on the scientific and economic significance of some of its component species. Some of the more complex families, such as the Compositae, have supplementary illustrations to aid in their analysis. The book closes with indices to families and genera, and to English names. It is bound in cloth and is of handy size for carrying in the field.

H. M. RAUP

DRAWINGS OF BRITISH PLANTS. *Being Illustrations of the Species of Flowering Plants Growing Naturally in the British Isles. Part I. Ranunculaceae. Part II. Berberidaceae, Nymphaeaceae, Papaveraceae, Fumariaceae.*

By Stella Ross-Craig; with a foreword by Sir Edward Salisbury. G. Bell and Sons, London. (I) 6s. (II) 4s. 6d. (paper). (I) 12 pp. + 44 plates; (II) 11 pp. + 22 plates. 1948.

The two volumes at hand consist entirely, except for the Foreword and brief introduction (duplicated in each), of superb drawings of British plants. The books are printed in octavo, and the drawings for each species cover a single page. The pages are printed on one side only, so that the drawings may easily be clipped.

H. M. RAUP

TASCHENATLAS DER SCHWEIZER FLORA. *Mit Berücksichtigung der ausländischen Nachbarschaft.*

By Eduard Thommen. Verlag Birkhäuser, Basel. S. fr. 12.50. xvi + 294 pp.; ill. 1945.

This is a small handbook, bound in cloth, and suitable for easy field reference. With the exception of a brief introduction and list of author abbreviations, it consists almost entirely of small but clear line drawings of the flowering plants and ferns of Switzerland. The drawings include habit sketches and a wealth of detail showing the definitive characters of the species. The book closes with a partial list of the species, in which there are notes on range and occurrence. An index covers the genera, and the species in some of the larger genera. American botanists traveling in Switzerland should find the book useful for the determination of the native flora.

H. M. RAUP

AN AUSTRALIAN WILD FLOWER BOOK. *Second Edition.*

By Charles Barrett. Geoffrey Cumberlege, Oxford University Press, Leighton House, Melbourne. $3.00. 205 pp. + 39 plates. 1947.

This small pocket volume contains descriptions of some of the more conspicuous Australian wild flowers. It is entirely non-technical, with no keys for identification, and consists of descriptive essays. Its arrangement is primarily geographical, as the following chapter heads indicate: Gems of the Bush, On the Heathlands, Western Wild Flowers, Tropical Beauty, Tasmania's Flora, etc. There is much lore concerning the history of the plants, their distribution, their appearance in cultivation, and the botanical exploration of Australia. The book is illustrated with handsome photographs in black and white or in color.

H. M. RAUP

NOTES ON THE ACANTHACEAE OF JAVA. *Verhandelingen der Koninklijke Nederlandsche Akademie van Wetenschappen, Afd. Natuurkunde. Tweede Sectie, Deel XLV, Number 2.*

By C. E. B. Bremekamp. North-Holland Publishing Company, Amsterdam. F. 3.50 (paper). 78 pp. 1948.

This publication consists of critical notes on many genera and species in this complex family, with descriptions of new entities in both categories. The author presents

some revisions in the organization of the family as it was expressed in his earlier publications.

H. M. RAUP

FLORE ANALYTIQUE ET SYNOPTIQUE DE LA NOUVELLE-CALEDONIE PHANEROGAMES. *Flore de la France d'Outre-Mer.*

By A. Guillaumin. Office de la Recherche Scientifique Coloniale, Paris. 1200 fr. (paper). 369 pp. 1948.

Guillaumin has for many years been a student of the flora of New Caledonia, and now presents in this volume analytical keys to the phanerogamic plants of that area. The key is arranged by families, and follows, in general, the system of Engler and Prantl. Under each family there is a brief description of the characters of the family as a whole, a key to its genera, and then keys to the species under each genus. The text is in French. An index at the end is limited to families and genera.

H. M. RAUP

PLANT MORPHOLOGY

PRACTICAL PLANT ANATOMY. *Second Edition.*

By Adriance S. Foster. D. Van Nostrand Company, Inc., New York, Toronto, London. $3.00. xi + 228 pp. 1949.

The appearance of a second, completely revised and enlarged edition of *Practical Plant Anatomy* less than 10 years after its original publication readily attests the great popularity and wide acceptance of this exceedingly useful and highly informative book. The great advances in plant anatomy achieved in the interim have been carefully recorded in the largely rewritten and expanded chapters. These changes and the addition of a new exercise (no. 12) on laticiferous tubes, the laboratory directions of which were contributed by Katherine Esau, have increased the text by more than 70 pages. The physical make-up, too, has been greatly changed, for the former spiral binding has been replaced by a regular book binding.

Throughout the book the emphasis has been admittedly and correctly placed on the study of the *vegetative* organs of the higher plants, rather than on that of their reproductive organs or other special structures often treated in advanced courses in plant anatomy and morphology. Each chapter consists of a critical review of the pertinent data, interpretations and theories concerning the particular material covered, instructions for laboratory work, and an extensive bibliography containing both classical and recent references. As the laboratory instructions include ample suggestions for the use of a great variety of plants, frequently of economically important species, *Practical Plant Anatomy* can easily be used in conjunction with courses of widely differing content and scope.

Traditionally, progress in plant anatomy has resulted from investigations carried out along two main lines of research, the structural and the developmental (or physiological). However, in recent years, paleobotanical research has yielded such phenomenal results that some of these could profitably be included in the study of living plants. The application of epidermal and especially stomatal characters in the identification and classification of fossil (mainly Mesozoic) and living gymnosperms provides one of the most striking examples. In the light of these researches, the exercise on stomata would undoubtedly read very differently.

With all the changes made, the original purpose of the book has not been altered. Rather, the second edition is even more eloquent testimony to the author's broad research and teaching experiences.

THEODOR JUST

ECONOMIC BOTANY

MANUAL OF CULTIVATED PLANTS *Most Commonly Grown in the Continental United States and Canada. Second Edition.*

By L. H. Bailey and the Staff of the Bailey Hortorium at Cornell University. The Macmillan Company, New York. $17.50. 1116 pp.; ill. 1949.

Ever since its appearance in 1923, Bailey's *Manual of Cultivated Plants* has been an indispensable reference work for all botanists, florists, and horticulturists. The appearance of a revised and up-to-date edition is most welcome. The new *Manual* is greatly enlarged, with 1523 genera and 5347 species now included (with incidental mention of many others), as against 1246 genera and 3665 species in the earlier work. Every effort has been made to bring the nomenclature into accord with the International Rules.

As in the first edition, the species treated are those commonly domesticated in the continental United States and Canada - the garden flowers, ornamental shrubs, greenhouse plants, vegetables, fruits, grains, grasses, and all other plants grown for food, ornament, usefulness or general interest, either in the open or under glass. Purely horticultural varieties are omitted.

In addition to the species commonly cultivated, three other categories are included: species which are no longer of commercial importance, but have been popular over the years and are still to be found in old gardens; new introductions not as yet fully established; and plants of importance in other parts of the world, which are as yet little known or appreciated in the United States.

The introductory material comprises a section devoted to the meaning of the specific names, a glossary of botanical terms, a list of the authorities for the binomials, and a key to the families of the Pterido-

phytes and Spermatophytes. The appearance and format of the book are excellent, and although much of the type is small, it is very easy to read. There are 195 text figures and a complete index. It is to be regretted that owing to present-day printing costs this valuable and essential work should have to be so high in price.

ALBERT F. HILL

FRUIT SCIENCE. *Orchard and Small Fruit Management. By Norman Franklin Childers; edited by R. W. Gregory. J. B. Lippincott Company, Chicago, Philadelphia and New York.* $5.00. x + 630 pp.; ill. 1949.

Although primarily intended for use as a college textbook, *Fruit Science* should also be valuable for fruit growers who wish to keep in touch with modern trends in pomological research. The method of treatment is quite different from that of most other works dealing with fruits. At least one-third of the book is devoted to the apple, which the author considers the most widely grown and the most important fruit. It is in connection with the apple that the underlying basic principles and practices of fruit growing are discussed. All phases of apple culture are included: regions, production, varieties, pruning, soil management, flower bud formation, pollination and fruit set, thinning, grafting and budding, frost injury, harvesting and packing, storing and marketing. Several chapters are devoted to other important deciduous fruits, such as the pear, quince, peach, nectarine, apricot, almond, plum, and cherry, in so far as their management differs from that of the apple. Small fruits - the grape, strawberry, raspberry, blackberry, blueberry, currant, gooseberry, and cranberry - are also considered.

Information is given with regard to the fruit industry, the establishment of orchards, control of insects and diseases, judging of contests and exhibitions, and the freezing preservation of fruits. Supplementary material includes a selected list of collateral readings for each chapter, an enumeration of the Agricultural Experiment Stations and Colleges in the United States and Canada, scientific journals in the field of pomology, a list of scientific names, and an index.

ALBERT F. HILL

BANANAS: *Chemistry, Physiology, Technology. Economic Crops, Volume I. By Harry W. von Loesecke. Interscience Publishers, New York and London.* $4.50. xii + 189 pp. + 2 plates; text ill. 1949.

With *Bananas*, Interscience Publishers present the first volume of a projected series of monographs dealing with the chemistry, physiology, and technology of food and food products. Quite aside from the manifest value of this book to those interested in food technology, there is compiled here a worthy store of information relating to the structure and development, chemical changes during ripening, respiration, volatile constituents, enzymes, and insect and fungus diseases of the banana. There are also chapters which deal with commercial storage and ripening methods, transportation, banana products, and nutritive values in health and disease. The account begins with the history and origin of the fruit and concludes with statistics describing world production and trade.

V. G. DETHIER

VEGETABLE SCIENCE. *By H. D. Brown and Chester S. Hutchison; edited by R. W. Gregory. J. B. Lippincott Company, Chicago, Philadelphia and New York.* $5.00. x + 452 pp.; ill. 1949.

This book is designed both as a manual for farmers who grow vegetables commercially and as a textbook for students. Fundamental modern practices are presented in a clear and concise manner. Economical procedures are stressed; and a brief history and description of each vegetable are given for those interested in the more academic phases of the subject. A series of review questions and a short bibliography are appended to each chapter. An index is also available.

ALBERT F. HILL

ORCHIDS ARE EASY TO GROW. *By Harry B. Logan and Lloyd C. Cosper; drawings by Lynette Arouni. Ziff-Davis Publishing Company, Chicago and New York.* $6.00. viii + 312 pp. + 20 plates; text ill. 1949.

The rapidly expanding role of orchids in horticulture created a demand for a manual of orchid culture which would be comprehensive in scope, simple in treatment, and factually sound, yet written in non-technical language. The authors have made a sincere and quite successful effort to meet this demand, keeping in mind the ever-increasing number of amateurs who have succumbed to the allurements of this royal family of plants.

The division of the book into two parts follows rather standardized practice in works of this kind. Part One, The Mechanics of Orchid Culture, treats orchids in general, discussing their geographical distribution, morphology, culture, and allied subjects of greenhouses, composts, pests, and diseases. A chapter is devoted to the outdoor culture of orchids and another to the growing of orchids in the home, with or without a growing case. Miniature greenhouses and Wardian cases are dealt with in another chapter.

Part Two, Orchids You May Grow, is in part a series of chapters, each devoted to a single genus of horticulturally popular orchids. The treatment is novel, being in narrative form rather than in the more customary descriptive paragraphs. In addition, the chapter on orchids for special purposes and another on cultural and descriptive tables are highly specific in content and should be of especial value to the connoisseur as well as the novice. An extensive bibliography and an adequate index conclude the work. Though the book contains a number of errors and some of the statements can be considered at least controversial, it is an excellent contribution to its field and will be a standard for comparison for any future work.

GORDON W. DILLON

GLADIOLI. *Second Edition. The Home Garden Books. By A. J. Macself. Eyre & Spottiswoode, London.* 6s. x + 87 pp. + 1 plate; text ill. 1948.

For several years there has been available a series of small handbooks, The Home Garden Books, which afford the amateur gardener practical and helpful information on a variety of subjects. One of these handbooks, devoted to Gladioli, has been completely revised to include new and up-to-date information, especially with regard to those modern developments which have enhanced the importance and serviceability of the plant. All phases of gladiolus cultivation are covered: early-flowering types; general culture; growing for exhibition, and for stock; cutting, packing, and staging; the adaptability of cut flowers; commercial culture, and growing from seed; pot culture; and diseases. A brief history of the plant and a list of species are included. The book has a short index and is illustrated with a colored frontispiece and 22 line drawings.

ALBERT F. HILL

GLADIOLI AND DAHLIAS. *By Chas. W. J. Unwin. W. H. & L. Collingridge, London.* 6s. 125 pp.; ill. 1949.

This little book is a highly authoritative guide to the successful cultivation of these two popular garden flowers. The author, a well known breeder, grower, and exhibitor, presents his facts in a very readable manner. The chapters devoted to Gladioli cover such topics as types and races, utilization for such varied purposes as shows, gardens, or the home, cultural notes for exhibitors, routine culture, raising young stock, and hybridization. Dahlias are discussed under such headings as varieties, cultural requirements, propagation, and hybridization. The author concludes with a plea for a return to the compost heap, rather than too great a dependence on chemical fertilizers.

ALBERT F. HILL

DELPHINIUMS. *Their History and Cultivation. Second Edition. The Home Garden Books. By George A. R. Phillips. Eyre & Spottiswoode, London.* 6s. x + 114 pp. + 5 plates; text ill. 1949.

A second handbook of the Home Garden series—devoted to Delphiniums—has also been completely revised and rewritten. The most recent cultural practices are described, and the newer as well as standard varieties are discussed. The scope of this little manual is such that it should be valuable to amateurs and commercial growers alike.

ALBERT F. HILL

SHRUBS FOR THE MILDER COUNTIES. *By W. Arnold-Forster; foreword by The Right Hon. Lord Aberconway; with a chapter on Magnolias by G. H. Johnstone. Country Life, London; Charles Scribner's Sons, New York.* $10.00. xvi + 367 pp. + 41 plates. 1948.

Although written for an English public, American gardeners and landscape architects will find much of value in this work. Unlike most books dealing with shrubs, the present volume emphasizes the more delicate species which can be grown in milder areas, as well as the hardier ones which have a wider range of usefulness.

One chapter is devoted to plants which are capable of withstanding sea winds; another is concerned with roadside, estate, and town plantings. The largest portion of the work—111 pages—gives a general planting list with a wealth of information concerning each species and derived from the author's lifetime experience as a practical gardener.

Special sections are devoted to acacias, camellias, *Ceanothus, Eucalyptus, Metrosideros, Nothofagus, Olearias, Prunus, Pyrus, and Sorbus,* Rhododendrons and Magnolias, the latter chapter by G. H. Johnstone, the eminent authority on this group. A final chapter is concerned with shrubs which are still in the experimental stage. There is an adequate index.

ALBERT F. HILL

THE STORY OF TOBACCO IN AMERICA. *By Joseph C. Robert. Alfred A. Knopf, New York.* $5.00. xiv + 320 pp. + 4 plates; text ill. 1949.

Some of our economic plants have played such an important role in the development of the United States that an account of their history is in great part a history of the nation itself. Such is the case with tobacco. The present volume traces the history of tobacco in America. It not only outlines the various phases of the industry itself, but also discusses the vital effect of tobacco on the political, social, and economic life of the country from earliest colonial times to the present.

The author, a professor of history at Duke University, in very readable words brings home his thesis that without some knowledge of tobacco it is impossible to understand fully such important events as the founding of the Chesapeake colonies, the development of slavery, the advent of the Revolution, or the early diplomacy of the Nation. States' rights, the growth of Big Business, and the agrarian aspects of the New Deal have all been affected by tobacco. Even more pronounced has been the impact of tobacco on the economic and social life of the country, with the changing customs in its use from snuffing and dipping through the rise of the cigar to the present amazing dominance of the cigarette.

The book is arranged in chronological order by periods. A list of the chapter headings and subtitles will give some idea of the scope of the work and the interesting subject matter:

1492–1776. The Discovery of "That Bewitching Vegetable"; First American Aristocrats—Sweet Scented and Oronoko; Great Planters of the Tidewater; Tobacco Merchants of Britain; The Parson's Cause.

1776–1860. New Fields and Changing Markets—The Revolution and Diplomacy; Frontier Planters and the "Spanish Intrigue"; A Revision of Plantation Arts; Rollers, Boatmen and Auctioneers. The Chewing Tobacco Era—Industrialists in an Agrarian Society; Slaves in the Tobacco Factories; Trade Names and Wooden Indians; Reformers and the Tobacco Habit.

1860–1911. The New South and Big Business—In the Land of Johnny Reb; The Birth of the Golden Calf; The Old Guard and Newcomers; W. Duke & Sons; The Tobacco Empire. The Age of Conflict—Night Riders *versus* Hill Billies; "Blood Money" and Trust Busters; The Little White Slaver; Drummers and Cigar Makers; Bright Leaf and Burley.

1911–1941. Farmer and Leaf Market—The Warehouse Scene; Troubled Waters of the Tobacco Pools; Tobacco and the New Deal; The Modern Tobacco Farmer; Marshall's "Really Good Five-cent Cigar." The Cigarette Age—Camels Lead the Way; The All-American Cigarette; And Still the Coffin Nail; The Battle of Lexington, Kentucky.

1941–1948. The End of Tobacco Road.

A very complete bibliography and index add much to the value of the book.

ALBERT F. HILL

DRUGS FROM PLANTS. *Sigma Introduction to Science, 10.*

By Trevor Illtyd Williams. Sigma Books, London. 6s. 119 pp. + 12 plates. 1947.

The author of *Drugs from Plants* believes it important for cultural and economic reasons to furnish the general reader with popular interpretations of science. In this book he has most effectively presented accurate information regarding vegetable drugs in an entertaining and readable manner. His subject is well chosen, for few other fields combine such a fascinating and well documented period of empiricism and superstition with a later one of precise scientific method.

In an introductory chapter, Williams gives a brief history of the medicinal uses of plants from the time of Egypt, Babylon, and Assyria to the days of the Herbalists and the Doctrine of Signatures. He then shows how scientific methods of investigation have made it possible to distinguish the few really useful plants from the great mass of remedies which had their origin in ignorance and superstition, and to assess their true value. A chapter on the classification of drugs, chiefly from the chemical standpoint, is followed by a detailed account of seven important drugs—quinine, hashish, digitalis, penicillin, ergot, opium, and cocaine. Another chapter is devoted to miscellaneous drugs, including belladonna, hyoscyamus, mandrake, aconite, poison hemlock, hellabore, strychnine, caffein, colchicum, ephedrine, calabar beans, chaulmoogra, and curare.

The final chapter, What of the Future?, is of special interest. The author feels that continued research will lead to the discovery of additional valuable drugs and also make possible important contributions in the fields of botany and chemistry. As possible topics for investigation the author suggests the following: antibacterial properties; the development of synthetic drugs following the study of natural ones; the mode of action of drugs and the relationship between their chemical structure and physiological action; the manner in which the drugs are formed and their function in the plant's economy; the search for new and high-yielding strains, or their development through breeding; and the use of chemical methods in botanical classification.

ALBERT F. HILL

GREEN GLORY. *The Forests of the World.*

By Richard St. Barbe Baker, with a foreword by Howard Spring. A. A. Wyn, Inc., New York. $3.50. 253 pp.; ill. 1949.

This is a story of the forests of the world: their extent, character, and variety; their role in maintaining a balance in nature; their destruction, management, and replacement; and, lastly, but most important, the consequences of their mismanagement upon the character of the countryside and upon the economy of nations. It is a story which has been told many times before, but rarely so effectively. With the possible exception of South America, no region of the world has been spared the destruction of its forests which has so closely followed the colonization of the land. Only a handful of nations—Sweden, Finland, Russia, Yugoslavia—have recovered to a point where the harvesting of trees is matched by the rate of replacement. The consequences

have been inevitable and disastrous. The floods of the Yellow River which have depleted great areas of topsoil in China; the steady advance of the Sahara and Arabian deserts, which but short centuries ago were clothed in forests; and in our own country, the Dust Bowl of the 1930's, the passing of the tremendous white pine forests of the north, and the perilous lowering of the water table in the southwest are but a few examples of the effects of widespread deforestation. Roosevelt's Civilian Conservation Corps, formed in the depression days to combat unemployment, can trace its origin to forest depletion and the need for conservation practices.

This book, however, is more than an eloquent plea for conservation. It is an urgent warning that the well-being of a nation—and the United States is no exception—is intimately bound up in innumerable ways with its forest resources, and that the destruction of these without their replacement is national suicide. To be sure, steps have been taken to replace our dwindling reserves, but the United States, like other nations, long ago passed the point of being self-sufficient in this respect. The author knows his subject, and he speaks with a conviction arising out of this sure knowledge. One can only wish that his proposal to the United Nations to turn the armies of the world into foresters would be considered seriously by all nations. If a criticism of the book is to be made, it is that the style of writing is too flowery and sentimental. Chapters 1, 3, and 5 could just as well have been omitted as superfluous. These shortcomings, however, are compensated by a number of superb photographs, and by the thoroughly interesting subject matter.

C. P. SWANSON

FOREST PATHOLOGY. *Second Edition. The American Forestry Series.*

By John Shaw Boyce. McGraw-Hill Book Company, New York, Toronto and London. $6.00. xii + 550 pp.; ill. 1948.

The present revision brings up to date the topics discussed in the 1938 edition of Boyce's well-known book. The specialized field of forest pathology encompasses portions of many and varied botanical sciences. Consequently, the compilation of the data on this subject in a book that serves equally well as a textbook for the student, a source of enlightenment for the conservationist, and a reference for the specialist, is to be highly commended.

The subject is most logically treated, from an excellent introduction through diseases of the seedling and the mature tree, the deterioration of dead timber and of forest products, and, finally the principles of disease control. Supplementing the chronological treatment, the diseases are grouped according to the part of the host attacked. This approach, instead of that by the causal agent, enhances the usefulness of the book for those who are not trained pathologists. The new forest diseases are discussed, and there is a change in emphasis on some of the old. However, the author does not contend that the amount of space allotted to a specific disease is consistent with its economic importance. The book is based on published literature, so that the amount of such information available has greatly influenced the length of discussion of a given disease. Comprehensive lists of references are given at the end of each chapter. Like its predecessor, this book will be invaluable to all those interested in forest pathology.

BERCH W. HENRY

AUSTRALIAN JOURNAL OF AGRICULTURAL RESEARCH. *Volume 1, Number 1. January 1950.*

Editorial Advisory Committee: Chairman and Editor, Dr. N. S. Noble. Members: Dr. H. E. Albiston, Dr. L. B. Bull, Dr. H. C. Forster, Associate Professor G. W. Leeper, Professor S. M. Wadham. Commonwealth Scientific and Industrial Research Organization in collaboration with the Australian Institute of Agricultural Science and the Australian Veterinary Association. 30s. per year (four issues per year). No. 1: Pp. 1-102; ill.; 1 plate.

This journal has been founded to publish original investigations into the physical, chemical, and biological aspects of soils, plants, and animals. It will presumably supersede, at least to a considerable degree, the series of Bulletins published by the C. S. I. R. on these subjects. Each article is preceded by a summary. Contents of the first issue: Some effects of leaf-roll virus on the development and growth of the potato plant (J. G. Bald & E. M. Hutton); Transmission of potato virus diseases. VI. The distribution of the aphid vectors on sampled leaves and shoots (J. G. Bald, D. O. Norris, & G. A. Helson); Seedling blight. I. Seed colour and soil in relation to pre-emergence blight of William Massey peas (H. R. Angell); Pot culture studies of the copper and molybdenum content of certain pasture plants (C. W. E. Moore); Differential effects of certain phenoxyacetic acid compounds and phenylcarbamates on plant species. I. Effect of applications to the soil prior to emergence (R. M. Moore); On the abundance of the Australian plague locust, *Chortoicetes terminifera* Walker, in relation to the presence of trees (L. R. Clark); Mating and lambing in an experimental flock of merino sheep (J. F. Kennedy & R. A. Bettenay); A technique for the collection of nematodes from the alimentary tract of sheep (F. J. Hamilton); Methods for egg counts and larval cultures for Strongyles infesting the gastro-intestinal tract of cattle (F. H. S. Roberts & P. J. O'Sullivan).

THE NON-PARASITIC DISORDERS OF APPLE FRUITS IN AUSTRALIA. *Commonwealth of Australia, Council*

for Scientific and Industrial Research, Bulletin No. 238.

By W. M. Carne. Council for Scientific and Industrial Research, Melbourne, Australia. Free upon request (paper). 83 pp.; 24 plates. 1948.

GENERAL AND SYSTEMATIC ZOOLOGY

AN INTRODUCTION TO ANIMAL BIOLOGY. *Third Edition.*

By John B. Parker and John J. Clarke. The C. V. Mosby Company, St. Louis. $4.00. 554 pp.; ill. 1949.

Little change marks this new edition of a college zoology textbook prepared especially for Roman Catholic schools. The chapter on Vitamins and Hormones has been brought up to date, and the major Rh blood types are given space. Non-Catholic biologists who wish to see how the subject of Organic Evolution is treated by Roman Catholics will find this book a good one to consult.

LABORATORY DIRECTIONS FOR GENERAL ZOOLOGY. *By Department of Zoology Staff, The State University of Iowa. The Williams Surgical Supply Company, Iowa City; Burgess Publishing Company, Minneapolis.* 85 cents (paper). vi + 36 pp. 1945.

A LABORATORY MANUAL FOR ELEMENTARY ZOOLOGY. *Revised Edition.*

By W. Byers Unger and C. E. Moritz. Ginn and Company, Boston, New York, Chicago, Atlanta, Dallas, Columbus, San Francisco, Toronto and London. $2.25. vi + 184 pp. 1949.

This reviewer will give up the attempt to render any further opinions on laboratory manuals for general zoology. Each one that turns up is different, not only in philosophy of approach to the subject matter, but also in choice of laboratory animals, amount of dissection and observations required, use of terminology, etc. Any particular instructor needs only to decide how he wants to teach the course and then scout around until he finds a suitable manual. Even with such a wealth of material available, he probably won't be satisfied until he devises one of his own. Since the manual is so intimately tied up with the manner of presenting the subject, any criticism of the former is merely a reflection on the latter.

Under present discussion we have the Dartmouth College and State University of Iowa manuals. The former is cloth bound, the latter paper bound with spiral rings. Both are printed only on one side of the page, the former on the left, the latter on the right and in two columns. The Dartmouth manual starts with a page on terminology and proceeds with the workings of the microscope. The Iowa Manual starts with general information on drawings, supplies, locker assignments, and what would appear to indicate an anticipated limited distribution, a paragraph to the effect that lost articles are placed in Room 105. The first study commences with the frog and describes external features, through muscles and sensory organs. This is followed by the study of the microscope, then cells and tissues, mitosis, and maturation through cleavage. Then follow studies on successive phyla from the Protozoa to *Drosophila*. The latter initiates the study on heredity. The final study, a survey of selected phyla, is apparently adaptable for Iowa courses, since it is condensed to three paragraphs devoted to demonstration material.

The Dartmouth Manual continues its microscope study with a survey of the phyla, culminating with the frog. A study of vertebrate systems follows, using the frog as type, although dog skeletons, pig kidneys, and sheep brains are included. Embryology, histology, cytology (i.e., gametogenesis in frog and mouse), and meiosis and mitosis in *Ascaris* complete the work. Broadly speaking, the Dartmouth manual does not go into quite so much detail per animal as the other, but includes more different kinds. The sequence is obviously the most differentiating characteristic and as was said, the value of each method cannot be honestly evaluated without knowing the nature of the complete course itself.

HENRI C. SEIBERT

THE SPONGES OF WOODS HOLE AND ADJACENT WATERS. *Bulletin of the Museum of Comparative Zoölogy at Harvard College. Volume 103, Number 1.*

By M. W. de Laubenfels. Museum of Comparative Zoölogy, Cambridge. $1.00 (paper). 56 pp. + 3 plates. 1949.

"First, an account, with detailed descriptions, illustrations, and a key to the known and highly probable species of Woods Hole itself. Second, an annotated review of the literature references to sponge occurrences from Newfoundland at the north to the Carolinas at the south."

THE PYCNOGONIDA OF THE WESTERN NORTH ATLANTIC AND THE CARIBBEAN. *Proceedings of the United States National Museum, Volume 97, Number 3216.*

By Joel W. Hedgpeth. Smithsonian Institution, Washington, D. C. Paper. Pp. 157–342 + 1 map; text ill. 1948.

REPORT ON THE PYCNOGONIDA COLLECTED BY THE ALBATROSS IN JAPANESE WATERS IN 1900 AND 1906. *Proceedings of the United States National Museum, Volume 98, Number 3231.*

By Joel W. Hedgpeth. Smithsonian Institution, Washington, D. C. Paper. Pp. 233–321 + 1 map; text ill. 1949.

THE FIRST BOOK OF BUGS.

By Margaret Williamson. Franklin Watts, New York. $1.50. 45 pp.; ill. 1949.

This book describes various activities of insects that should be readily observed by the children for whom it is intended. Included are crickets and their relatives, ants, moths and butterflies, bees and wasps, and other insects. In addition, spiders are included, but as the author specifically states, her use of the term bug is to be taken in the popular rather than in the scientific sense.

Although the style is quite anthropomorphic, it must be remembered that this is a book for children who, if interested, can learn the facts of life later. The material is well presented and is supplemented by many attractive colored illustrations.

JOHN CUSHING

WHAT BUTTERFLY IS IT?

By Anna Pistorius. Wilcox & Follett Company, Chicago, New York and Toronto. $1.25. 25 pp.; ill. 1949.

The title of this book reveals its purpose very well. It consists of a series of colored pictures of 26 common butterflies that are very well executed and enable the beginner to make rapid and easy identifications. Accompanying each picture is a paragraph on some of the characteristics of the butterfly figured. These individual comments on life histories are preceded by a general account, a page in length, telling how a butterfly grows.

Although primarily for older children, this book should also be of interest to adults who would like to make a casual acquaintance with butterflies.

JOHN CUSHING

THE NEARCTIC MEMBERS OF THE GENUS LYCAEIDES HÜBNER (LYCAENIDAE, LEPIDOPTERA). *Bulletin of the Museum of Comparative Zoölogy at Harvard College. Volume 101, Number 4.*

By V. Nabokov. Museum of Comparative Zoölogy at Harvard College, Cambridge. $1.60 (paper). ii + Pp. 479–541 + 9 plates. 1949.

A study of the subspecific forms of *L. argyrognomon* and *L. melissa*. Ten subspecies are assigned to the former species, two being new, and five are assigned to the latter species, one being new.

COLEOPTERA OR BEETLES EAST OF THE GREAT PLAINS. *By J. Gordon Edwards. Published by the author, 392 Prairie Avenue, Wilmington, Ohio.* $3.50. viii + 181 pp.; ill. 1949.

Undoubtedly there are still great gaps in our knowledge of the classification and biology of the insects. This is chiefly due to the enormous number of species in existence. One great drawback is that for many groups there is no easy way by which a species can be identified. Probably many more persons would become interested in this subject were it not for such stumbling blocks encountered at the very beginning of the study of insects. This is particularly serious for the beetles, which form the largest order of insects, and of which about 24,000 species are known to exist in the United States alone.

It is practically impossible for a beginner to identify a beetle which he might encounter in a fauna relatively as well known as that of the eastern United States; in many cases it is even very difficult for a person with considerable experience. There has never been a manual covering this area. The closest approach has been Blatchley's well known *Coleoptera of Indiana* which, besides being restricted to one state, has now a somewhat antiquated approach and has, moreover, been out of print for many years. The difficulties exist even when one is satisfied to track the beetle down only to family or genus. Practically all the keys that have been published make use of characters which are difficult to observe for the uninitiated worker. Furthermore, in nearly every key with which the reviewer has come in contact there are demonstrable inconsistencies and errors.

This book by Edwards is a very welcome step in the right direction. It consists of an extensive key to the beetle families (sometimes to smaller units), a description of the chief characteristics of each family, brief descriptions of the principal species, including their larvae, biological remarks, and finally a list of the principal publications dealing in detail with the species of that family. The author breaks with a few traditions, which is fortunate in some instances, less fortunate in others. The family key is not just a modified copy of previous keys but is a new approach, using wherever possible simple characters that can be recognized by the beginner. As the sole purpose of a key is a quick and unambiguous identification of a specimen, this is highly commendable and needs no apology. On the other hand, if the fundamental characters which define the family are avoided, there is danger of a slip now and then, and this the author has not entirely avoided. It would, for instance, be impossible to track down the common Mexican bean beetle in the family key, or, if one would guess its family correctly, to identify it from the description under the family Coccinellidae, as the author has overlooked the fact that *Epilachna* is one of the hairy

genera of lady beetles. There are similar flaws in other groups.

The literature references are very valuable. Anyone who actually wants to identify a beetle as to species will need to have recourse to the original descriptions or to more recent revisions of certain groups. It is somewhat puzzling why certain publications were included, but others omitted. Blatchley's *Coleoptera of Indiana* is mentioned 99 times, whereas such papers as, e.g., Dobzhansky's monograph on the genus *Coccinella*, Leng's revision of *Brachyacantha*, and Dawson's papers on *Serica*, without which any attempt to classify beetles of these genera would be futile, have been omitted. The book is illustrated with many drawings which make it much easier and more definite to recognize the characters important for the identification than would any number of descriptive words.

This book can be highly recommended to the beginner in the study of beetles, if he realizes that it is not infallible. It is to be hoped that the author will soon be able to bring out a second edition from which the shortcomings could be easily eliminated.

G. H. DIEKE

COLEOPTERA: CLERIDAE. *Contributions toward a Knowledge of the Insect Fauna of Lower California. No. 12. Proceedings of the California Academy of Sciences. Fourth Series. Vol. XXIV, pp. 485–519. January 26, 1950.*

By William F. Barr. The California Academy of Sciences, San Francisco. 65 cents (paper). 34 pp. 1950.

Forty-one species, six of which are new, and two subspecies are treated in this paper. Ten of the previously known species and subspecies are recorded from Lower California for the first time.

OBSERVATIONS ON BATRISODES (COLEOPTERA: PSELAPHIDAE), WITH PARTICULAR REFERENCE TO THE AMERICAN SPECIES EAST OF THE ROCKY MOUNTAINS. *Bulletin of the Chicago Academy of Sciences, Volume 8, Number 3.*

By Orlando Park. Chicago Academy of Sciences, Chicago. Paper. Pp. 45–132 + 11 plates. 1947.

CHECKLIST OF THE GENUS BATRISODES (COLEOPTERA: PSELAPHIDAE). *Bulletin of the Chicago Academy of Sciences, Volume 8, Number 4.*

By Orlando Park. Chicago Academy of Sciences, Chicago. Paper. Pp. 137–169. 1948.

THE RELATIONSHIPS AND ZOOGEOGRAPHY OF THE GENUS THALEROPHIS OLIVER. *Bulletin of the American Museum of Natural History. Volume 92: Article 4.*

By James A. Oliver. American Museum of Natural History, New York. $1.75 (paper). Pp. 157–280 + 4 plates; text ill. 1948.

It is almost traditional for University of Michigan herpetologists to compile excellent generic monographs. Ruthven's revision of the garter snakes in 1908 was an impressive pioneering work. Blanchard's review of the king snakes in 1921, Ortenburger's of the racers in 1928, and Gloyd's of the rattlesnakes in 1940 are a few additional examples of this outstanding series. The present contribution continues, and in some ways extends, the high standards that have come to be expected by systematic zoologists.

Thalerophis is a genus of green, semi-arboreal to arboreal, neotropical snakes in which Oliver distinguishes six species, one of which has 2 races and another, 12 races. The genus is most closely related to other neotropical genera (*Drymobius* and *Dryadophis*) and not to superficially similar tree-snakes of the Old World, as has previously been thought. The genus probably originated in lower Central America, from which locality it has spread, northward and southward, into virtually all of the humid, warm, lowland, forest areas of the western hemisphere.

The paper is organized into a number of sections which are, essentially, as follows: taxonomy, character analysis and clines (in which is included a good deal of general ophidian biology), individual species accounts, and general phylogenetic considerations. There is a bibliography.

The disentanglement of a rather complicated nomenclatorial snarl seems to have been capably handled. Oliver has joined with a small group of rebels in not using parentheses (as required by the International Rules of Zoological Nomenclature), presumably because he has felt that they have not been used properly by many zoologists and, therefore, to that extent have lost their meaning. His general systematic philosophy is conservative, if conservatism is interpreted to mean placing forms in the least inclusive applicable taxonomic category; he writes: "... it appears to me to be more logical in the absence of definite proof of intergradation or reproductive isolation between closely related allopatric or geographically vicarious forms to consider them as subspecies rather than species." (p. 166).

The material on morphological characters is treated in a refreshingly novel fashion and is especially well handled. There are many attempts at analyses of quantitative data which seem to be done with concepts of modern genetics and population biology rather than with a consideration of specimens as a chance collection of natural artifacts. Unfortunately, the analyses are largely qualitative or only partly quantitative. There is much information in the raw data that has not been extracted, and the raw data are not available in the paper. This particular section will be of interest not only to specialists concerned with the genus

but also to a large number of general systematic zoologists, regardless of the group with which they are primarily concerned.

The accounts of the individual species comprise a monument to the author's effort. To an unusual degree, most of the information presented is new and relatively little is derived from compilation. For example, of the 18 recognized forms, one-third have been described by Oliver during the course of this study. These accounts are illustrated with spot distribution maps and with excellent and striking drawings of heads, scale patterns, and hemipenes. Each species account contains an outline synonymy (a single citation for the first use of each name applied to a form), a statement about the type locality and range, and a fairly detailed description of scutellation and color. The account continues with a discussion of variation and various pertinent remarks. Each account is concluded with a list of the specimens that were examined, giving locality data and museum number. All in all, about 900 specimens were studied; for one race Oliver had available as many as 194 specimens, yet for another, only 5. There are keys to the forms. An additional welcome feature would have been a table to summarize the ranges of the more important systematic characters for each of the forms.

Oliver has spared no effort in gathering information about these snakes, even if it was not particularly germane to the present paper. He has an interesting section on food habits, in which it is rather clearly pointed out that although the snakes are diurnal, the organisms that make up their diet (largely hylid frogs) are nocturnal or crepuscular in habit. He suggests: "There may be possible advantages to a predator in locating its prey at a time when the latter is in a quiescent state and from which it emerges under a relative disadvantage in sensory efficiency as compared with that of the active predator."

The format is very pleasing and the editorial work is of the same high standard as the content; I was able to locate only two minor typographical errors.

ARNOLD B. GROBMAN

A REVISION OF THE BIRD FAMILY DICRURIDAE. *Bulletin of the American Museum of Natural History. Volume 93: Article 4.*

By Charles Vaurie. American Museum of Natural History, New York. $1.75 (paper). Pp. 199–342; ill. 1949.

Not since 1877 has the family Dicruridae, the drongos, been revised, with the result that the taxonomy of this group has become hopelessly out of date. The present revision is based on an examination of nearly 3600 specimens, including all but two of the accepted forms. The 14 or so genera into which the family was originally divided is herein reduced to two, one being monotypic. These are *Chaetorhynchus*, whose tail has 12 rectrices, and *Dicrurus* with 10 rectrices. Twenty species are recognized in the latter genus, some of which contain many geographical subspecies. This lumping results from the fact that characters formerly considered as being of generic distinction show considerable overlap when large series are compared, and the same situation exists with what were formerly considered specific differences. The probable evolution of various characters such as tail, crest, and eye color are discussed as well as traced geographically on maps. The synonymy is complete, and each species and subspecies is described as to plumage, size, and range. In spite of this rather exhaustive treatment, only one new form is described, *Dicrurus hottentotus renschi* from Sumbawa, and only one new name proposed, *D. paradiseus ceylonicus*. A large table gives comparative measurements of significant parts of all forms. Professional ornithologists with taxonomic inclinations will welcome this important contribution, which will become a standard reference for this family of birds.

HENRI C. SEIBERT

STUDIES IN THE PERAMELIDAE (MARSUPIALIA). *Results of the Archbold Expeditions. Number 60. Bulletin of the American Museum of Natural History. Volume 92: Article 6.*

By G. H. H. Tate. American Museum of Natural History, New York. 50 cents (paper). Pp. 313–346; ill. 1948.

ECONOMIC ZOOLOGY

A TEXTBOOK OF AGRICULTURAL ENTOMOLOGY. *Second Edition.*

By Kenneth M. Smith. Cambridge University Press, Cambridge and New York. 18s. xiv + 289 pp.; ill. 1948.

After 17 years this edition again brings into print a small, concise manual of specific farm and livestock pests of importance in Great Britain. It is hardly a textbook, as the term is used in the United States, but a rather technical reference for the trained entomologist. Its small size is made possible by the exclusion of fruit insects and by inclusion of very little in the way of general discussion, which omits even insecticides and equipment.

The first three chapters, respectively, consider the organization of agricultural entomology (agencies) in England and Wales; methods of insect control through cultural, biological, and legislative means; and the effect of weather conditions on insect outbreaks.

The next ten chapters deal with the various insect pests under their taxonomic positions in the several orders, with but short diagnostic statements for the order, suborder, or family. No keys or elementary morphology are presented, the reader being referred for these to Imms' *General Textbook of Entomology*. Each species is described in full detail in its various stages, but the terms used are those of the taxonomist. Brief notes are given regarding control, but equipment is taken for granted in most instances. Rather thorough treatment of the life history and the natural enemies of each pest is one of the commendable points of the book. The fourteenth and final chapter discusses the insects and virus diseases of crops in a detailed fashion under each crop. In spite of the vast literature on plant viruses and their transmission, the bibliography of this chapter contains but four cited references, of which two are papers by the author.

There are two excellent appendices, the first of which tabulates by crops the symptoms characteristic of insect attack, while the second tabulates by botanical names the common forms of weeds which serve as alternate hosts for many insect pests. A separate index of parasites and predators follows the appendices, and is arranged alphabetically by scientific name under the insect orders, with the page reference cited for each host.

Since the first edition of this book appeared in 1931, it is only reasonable to expect considerable revision in the present volume, but unfortunately this second edition represents little more than a reprinting. Perfunctory additions have been made in a few instances, with none of the book having been rewritten except the final chapter on viruses and a very few sections on life history or control. As a result, the earlier pagination and illustrations have been successfully retained up to the last chapter; only one new reference (p. 187: 23A) could be found among the several appended bibliographies for the first 13 chapters; and more surprising, the first paragraph of the introduction remains as written in the first edition, leaving the reader to ponder statements which are curiously out of place.

ROBERT MATHESON

THE COMMERCIAL FISH CATCH OF CALIFORNIA FOR THE YEAR 1947 WITH AN HISTORICAL REVIEW 1916–1917. *State of California, Department of Natural Resources, Fish Bulletin Number 74.*

By the Staff of the Bureau of Marine Fisheries. Division of Fish and Game, Bureau of Marine Fisheries, State of California Department of Natural Resources, Terminal Island, California. Paper. 268 pp.; ill. 1949.

This 30-year review, covering the period of California's rise to a major fisheries state, includes, in addition to the summaries of the catches of important commercial fishes, information on shellfish, octopus, and whales, and to a limited extent, data on sport fishing and bait species. Seaweed landings are omitted.

FISHING THE ATLANTIC.

By S. Kip Farrington, Jr. Coward-McCann, Inc., New York. $6.75. xxii + 312 pp.; ill. 1949.

Farrington covers the Atlantic, from Nova Scotia to Venezuela, the Bahamas, and selected spots on the other side. His idea of fishing is the chartered boat, elbow-bending approach, and over half the book deals with how big the fish are north of New Jersey. Apparently he spent one day in Texas, at that place where "they bite every day," and there seems to be no photographic evidence of his observation that "it is often possible to kill a limit of ducks before ten o'clock in the morning and catch redfish and tarpon before going in to lunch." We do have pictures of the author, the author's wife, and other worthies alongside their victims or gazing out to sea at the ones that got away. The sections on the European and African coasts are very sketchy, even from the big game fisherman's point of view. The illustrations by Lynn Bogue Hunt consist of a colored frontispiece and chapter headings. All very fine, if your idea of fishing is to catch them as big as possible and get your name in a record book.

JOEL W. HEDGPETH

AN INVESTIGATION OF OYSTER PRODUCING AREAS IN LOUISIANA AND MISSISSIPPI DAMAGED BY FLOOD WATERS IN 1945. *Special Scientific Report—Fisheries Number 8.*

By Philip A. Butler. United States Department of the Interior, Fish and Wildlife Service, Washington, D. C. Paper. ii + 36 pp. + 2 plates; text ill. 1949.

PARASITOLOGY

MEDICAL ENTOMOLOGY. *Second Edition.*

By Robert Matheson. Comstock Publishing Company, Ithaca. $7.50. xii + 612 pp.; ill. 1950.

This second edition represents a considerable revision, and much of the new book is concerned with the tremendous advances made in this field since 1932. The author states that he has attempted to bring together all data available by the end of 1948.

There are 20 chapters. The first gives a brief historical account of the discovery of the transmission of certain diseases by arthropods, and the second is a general introduction to the Arthropoda. Chapters III–

XVI and XVIII deal with the orders and families of disease-transmitting arthropods; Chapter XVII is concerned with myiasis, Chapter XIX with poisonous and urticating arthropods, and Chapter XX with collecting, preserving, and mounting insects.

The various groups of arthropods are introduced with descriptions of their external and internal morphology, accounts which in the case of the ticks, the phylum Hexapoda, the order Diptera, and the family Culicidae are quite extensive. There are keys to certain classes, orders, families, genera, and to some species. These aids to identification are abbreviated, and although of use in student laboratory exercises, they are of limited value to the entomologist who wishes to make determinations without access to the special literature.

The essential features of the biology of the larger groups are summarized, and there are notes on the distribution, life cycles, and special habits of the more important species. The most valuable feature of the book is that it brings together most of the evidence for the incrimination of the vectors of disease. The list of proved arthropod vector species has increased greatly during the past 15 years. One addition to the second edition is a discussion of the arthropod-borne encephalitides, but unfortunately several of the viruses which have been isolated from wild-caught mosquitoes have been omitted. In a book of this size it would not be possible to summarize all of the voluminous literature on the transmission of malaria, yellow fever, and filariasis, and so tables are given listing the vector species, their distribution, and breeding habitats. The interpretation of this extensive literature is not easy, and one might question inclusion in the table of "principal vectors of malaria" such species as *Anopheles mangyanus* in the Philippines, *A. lungae* in Guadalcanal, and *A. pessoai* in South America, and the exclusion of *A. aquasalis*, *A. bellator*, and *A. cruzii* from the list of South American vectors. *Haemagogus spegazzinii spegazzinii* is not included among the list of yellow fever vectors. *H. splendens* and *H. equinus* are listed as having been found naturally infected, but no references are given. These species are known to be suitable laboratory vectors, and the finding of naturally-infected specimens would so increase their epidemiological importance that the work would merit a reference. The erroneous distribution given for some of the *Haemagogus* species is no doubt the result of the general state of confusion concerning the taxonomy of this genus.

With respect to control of the disease vectors, some species are dismissed with brief recommendations, while others are treated more extensively. Measures of control have been developing so rapidly that already this book is somewhat out of date. There is no reference in the index to chlordane, toxaphene, benzene hexachloride, or the pyrenones. Considerable space is given to the outmoded use of oils and Paris green as mosquito larvicides. Although DDT as an adulticide is discussed, the tremendous implications in the use of DDT and other residuals in control of malaria in rural tropical areas have been ignored. The standard arsenic dip formula for tick control is given, but there is no mention of the recent work on the newer dips, washes, and sprays.

It would be difficult to write a book that would summarize to everyone's satisfaction all of the various aspects of the rapidly expanding field of medical entomology. Matheson has attempted a compromise through brief discussions of some subjects which many readers may believe merit more extensive treatment. Nevertheless, this book will be a useful textbook for an introductory course in medical entomology.

LLOYD E. ROZEBOOM

ILLUSTRATED LABORATORY OUTLINE OF VETERINARY ENTOMOLOGY AND HELMINTHOLOGY.

By J. H. Whitlock. Burgess Publishing Company, Minneapolis. $3.00 (paper). iv + 87 pp.; ill. 1948.

This manual is obviously designed to meet the needs of the author's own course, but could be adapted without much difficulty for any general course in veterinary entomology and helminthology. The current practice in laboratory manuals of providing drawings to be labeled by the student has been followed. These drawings, all redrawn or adapted from other authors, are large, reasonably accurate, and clearly reproduced by photo-offset. There are 31 full-page plates, consisting of 242 figures, mostly line drawings. Although there is no separate bibliography, specific references are given in the legends to the figures. The descriptive portion of the manual, reproduced by mimeoprint, is necessarily general and somewhat limited in scope. Some of the descriptive taxonomic material is presented in tabular form. A key to the mites of veterinary importance is given. It is perhaps unfortunate that keys to other groups, both arthropods and helminths, are not also included.

ALAN W. DONALDSON

ANIMAL GROWTH AND DEVELOPMENT

LEHRBUCH DER EMBRYOLOGIE.

By Walter Brandt. S. Karger, Basel. Sw. fr. 56.00. xii + 648 pp.; ill. 1949.

It is a curious anachronism that most current textbooks of human and mammalian embryology are so deeply concerned with "pure" morphology that they have failed to take advantage of the great body of literature dealing with experimental embryology and elucidating many of the morphogenetic processes. Some of the more recent editions of certain classical textbooks have attempted to compensate for this deficiency by includ-

ing several chapters or portions of chapters describing some of the results of modern experimentation, but these sections tend to remain as islands separate and apart from the rest of the text. It is clear to cautious experimental embryologists that experimental results obtained on non-mammalian material cannot always be applied to the mammal. It is, however, only against a background of comparative embryology that many of the details of mammalian embryology fit into appropriate perspective, and only in the light of experimental data that the dynamic qualities of many of the morphogenetic processes can be appreciated. Yet there has been no really serious attempt to effect an integrative synthesis of comparative and experimental data with the morphological descriptions of embryogeny and organogeny which constitute the major content of the textbooks addressed to premedical and medical students. It is accordingly greatly to the present author's credit that he has made such an attempt.

In order to achieve this goal within the covers of a single volume of reasonable size, he has had to sacrifice some of the meticulous presentation of detail in which the fuller organological sections of Arey, Patten, and Hamilton, Boyd and Mossman excel. Furthermore, modern embryologists will sometimes disagree with some of his descriptions and interpretations, and in particular will question his presentation of the formation of the germ-layers in many of the vertebrate groups. His labeling, for instance, of the roof of the amphibian archenteron as "endoderm" will not be happily accepted even in relation to his mitigating statement that "das innere Keimblatt entwickelt drei Primitivanlagen: Die Chorda, das mittlere Keimblatt und die Darmanlage." His description of the formation of the layers in the chick is thoroughly incompatible with the results of the most recent experimental analyses on this form. His interpretation of mesoderm formation in *Amphioxus* is far closer to Hatschek's than to the more modern one of Conklin.

These are matters of detail, however, concerning which the student can draw his own conclusions by referring to the original literature, which this book will encourage him to explore. Any factual or interpretative deficiencies of the book are more than outweighed by the author's commendable contribution in coordinating modern comparative and experimental data with the classical material, and thus in presenting the mammalian embryo as an integrated and dynamically functioning whole.

JANE M. OPPENHEIMER

EMBRYONIC DEVELOPMENT OF THE PLATYFISH (PLATYPOECILUS), THE SWORDTAIL (XIPHOPHORUS), AND THEIR HYBRIDS. *Bulletin of the American Museum of Natural History. Volume 94: Article 4.*

By William N. Tavolga. American Museum of Natural History, New York. 85 cents (paper). Pp. 161-230; ill. 1949.

This article represents a doctor's dissertation submitted to New York University. The greater part of it (45 pages) deals with the normal development of *Platypoecilus*, a viviparous poeciliid fish; six pages are devoted to a comparison of *Platypoecilus* development with that of *Xiphophorus* and of *Xiphophorus-Platypoecilus* hybrids. When embryonic stages of *Xiphophorus*, of *Platypoecilus*, and of their hybrids were compared, points of difference were found in the stage of initial pigment differentiation, in the stage of caudal fin differentiation, and in the rate of growth.

JANE M. OPPENHEIMER

RECHERCHES SUR LE DÉTERMINISME DE LA SYMÉTRIE BILATÉRALE *dans l'Oeuf des Amphibiens. Suppléments au Bulletin Biologique de France et de Belgique, Supplément XXXI.*

By P. Ancel and P. Vintemberger. Laboratoire d'Évolution des Êtres Organisés, Paris. 1000 fr. (paper). iv + 191 pp. + 4 plates; text ill. 1948.

This communication includes a detailed description, discussion, and summary of an experimental analysis which the authors began in 1932 in an attempt to evaluate the degree to which the constitution of the virgin egg, the point of entrance of the spermatozoon, and gravity are involved in the determination of the plane of bilateral symmetry of the amphibian egg. Many of the results have been briefly reported in notes in the *C. r. Soc. Biol.*

The authors have been unable to find positive evidence of structural differentiation within the virgin egg responsible for determining either the position of entrance of the spermatozoon or of the plane of bilateral symmetry. They include, however, as positively demonstrated factors contributing to influence the position of the plane of symmetry, the point of entrance of the spermatozoon, the *rotation of orientation* of the egg, the inclination of the egg axis, the compression of the egg, and the *rotation of fertilization*.

The *rotation of orientation* they define as an early movement of rotation of the egg around its horizontal axis resulting from the action of gravity. In the eggs of *Rana fusca*, for instance, artificially activated according to the authors' methods, it occurs before the appearance of the perivitelline fluid, beginning, at 18° C., 10 to 15 minutes after activation and completed by 30 minutes after activation. The *rotation of fertilization* occurs later, beginning in comparable material one hour and 10 minutes after activation and ending an hour later. It brings the primary axis of the egg into an oblique position, its upper pole moving into what will be the ventral, its lower into what will be the future dorsal hemisphere. They claim to have demonstrated that the *rotation of fertilization* is not a

mass movement of the egg as a whole, but rather a movement of the egg-cortex over the subjacent protoplasmic layers.

The authors believe that the point of entrance of the spermatazoon, the *rotation of orientation*, the inclination of the egg axis, and the compression of the egg act as preparatory factors contributing to influence the direction of the *rotation of orientation*, and they consider that their microscopic preparations indicate the manner in which these preparatory factors exert their influence. They conclude, however, on the basis of a long series of experiments varying these factors alone and in combination, that it is the *rotation of fertilization* which acts as the ultimate factor in determining the plane of symmetry, and they consider it to be the *rotation of symmetrization* of the egg.

JANE M. OPPENHEIMER

VISION: *Its Development in Infant and Child.*

By Arnold Gesell, Frances L. Ilg, and Glenna E. Bullis, assisted by Vivienne Ilg and G. N. Getman. Paul B. Hoeber, Medical Book Department of Harper & Brothers, New York. $6.50. xvi + 329 pp.; ill. 1949.

This is the newest book from the Yale Clinic of Child Development, of which Arnold Gesell is director. It is essentially a verbal description of how infants and young children use their eyes in certain standardized test situations and in normal, everyday life. The authors appear to have two main theses: (1) visual behavior develops in an orderly sequence, much as other kinds of behavior do; (2) the development of visual behavior cannot be considered independently of the other types of behavior which mature at the same time. Both points are well substantiated.

On the whole, the book was disappointing to the reviewer. It is full of rich, beautiful prose, but is largely empty of solid, factual content. Read this sentence, for example: "His spatial domain is loosely organized, but his command of the meridians and dimensions of space is sufficiently firm so that his reactions are constructively fluid, rather than precariously instable"; or these, which incidentally keep recurring throughout the book: "FIVE is a nodal age. FOUR is fluid, but FIVE is in focus." Perhaps they may convey some meaning to other readers; but your reviewer found them, and many more like them, vacuous descriptions of human behavior.

There are 72 clear illustrations in the book, although some of these appear to serve no function other than to increase the printing cost. There is also a list of 55 Selected References at the end of the book. Several of these are actually mentioned in the text; it is difficult to see why some of the others were put on the list.

This is a particularly frustrating piece of work, because the authors evidently did some quantitative studies. In an appendix they discuss examination procedures which include retinoscopy, ophthalmoscopy, and measurements of acuity, phoria, accommodation, fusion, and so on. Surely *some* quantitative data must have been obtained. If the authors have such data, they have concealed them well. In short, don't read this book with the expectation that you will learn much about vision from it. If you want a pleasantly written description of what children do at various ages, then you cannot go wrong with this book. After all, it is written by authorities in the field.

A. CHAPANIS

THE STORY OF LIFE. *Nineteenth Edition.*

By Ellis W. Whiting; illustrations by Joan Walsh Anglund. Wilcox & Follett Company, Chicago, New York, and Toronto. $1.25. 48 pp.; ill. 1949.

This, a simple, straightforward book, now in its nineteenth edition, was designed to answer for young children the question where babies come from. It may be recommended for parents who may feel self-conscious about developing their own answers and who would like guidance on this point.

JOHN CUSHING

ANIMAL MORPHOLOGY

LES GLANDES ENDOCRINES RÉTRO-CÉRÉBRALES DES INSECTES (*Étude Morphologique*). *Supplément XXXII au Bulletin Biologique de France et de Belgique.*

By P. Cazal. Laboratoire d'Évolution des Êtres Organisés, Paris. 1000 fr. (paper). iv + 227 pp.; ill. 1948.

This publication represents a thesis presented to the Sorbonne for the degree of Doctor of Science. It is primarily a study of the gross structure and histology of the corpora allata and associated glandular and neural tissues. All major groups of insects are treated. The paper is profusely illustrated.

V. G. DETHIER

THE FEEDING ORGANS OF ARACHNIDA, INCLUDING MITES AND TICKS. *Smithsonian Miscellaneous Collections, Volume 110, Number 10, Publication 3944.*

By R. E. Snodgrass. Smithsonian Institution, Washington, D. C. Paper. ii + 93 pp.; ill. 1948.

HISTOLOGY AND HISTOPATHOLOGY OF THE EYE AND ITS ADNEXA.

By I. G. Sommers. Grune & Stratton, New York. $12.00. xiv + 784 pp.; ill. 1949.

This book attempts to present, in a general and readable way, the fundamentals of a well known and exhaustively investigated field. It was prepared in response to student requests that the author's lectures be made available in permanent form. Indeed, each chapter resembles an informal lecture such as might be presented to an interested but uncritical group. Each is simple in form, without detailed discussion of controversial points. A notable feature of the format is found in the sections on literature, following each of the 20 chapters. Here findings not specifically mentioned in the text are summarized in brief paragraphs in small print, often single sentences. Immediately following these resumés are commendably extensive bibliographies covering the years 1920-47. This interesting device unburdens the text of frequent references to authorities (a weight which has rendered so many texts unreadable), while still offering accessible sources for further reading.

The 69 photographic illustrations are mostly low power magnifications. The quality of the specimens varies, but the reproduction is good. A 20-page index closes the book, which can be recommended as a readable treatment of its subject, acceptably accurate although not authoritative.

F. N. Low

EXTERNAL MORPHOLOGY OF THE PRIMATE BRAIN. *By Cornelius J. Connolly. Charles C. Thomas, Springfield, Illinois.* $10.00. xiv + 378 pp.; ill. 1950.

It is a great pleasure to greet the publication of such a book as this. Drawn from comprehensive material, it is clearly written and beautifully illustrated with photographs, line drawings, and tabular material. It stays neatly within the confines of its subject matter, each topic being presented without undue brevity or excessive length. It fills a definite need in the literature on primate anatomy.

The Hrdlička collection in the U. S. National Museum was used for the study of fissural patterns in primate brains. All families among primates are represented in the 330 brains used. Most numerous are the apes and the catarrhine monkeys. The platyrrhine monkeys and the more primitive forms in the suborder Lemuroidea are less well represented. The findings are presented so as to collate well with subsequent chapters on human brain development and the brains of different modern races of man. A chapter on encephalometry describes an adaptation of the Schwarz Stereograph for brain measurement and presents some tabular data. Two chapters on endocranial casts describe the relationship of the cast to the underlying brain in the same individual in most apes and in modern man, serving as background for an interpretation of casts made from the skull fragments of fossil man. Other chapters deal with such topics as the relationships of cortical areas to sulci, and anthropoid and human sulcal relationships and homologies. There is an interesting foreword by James W. Papez.

One is impressed throughout by the author's skillful unemotional presentation of highly controversial topics. Such clearheaded consideration of facts, without any effort to push conclusions to one extreme or another, is a welcome ability (not to say innovation) in this particular field. Thus it becomes a convincing reality that the brains of the various genera of primates can, in most cases, be distinguished from one another by their external physical characteristics. All of them are clearly distinct from that of man, but point up the human brain as the end point of an increase in size and complexity of fissuration. The brains of fossil man apparently occupy an intermediate position encephalometrically between the apes and modern man, although their fissuration is uncertain. Among the races of modern man differences are those of frequency, individual measures overlapping. The racial identity of single individuals cannot be determined with certainty from the physical characteristics of their brains. This purposeful book, which could not have been prepared without long and painstaking effort, reflects great credit on the author. It is recommended without reservation.

F. N. Low

A TEXTBOOK OF NEUROPATHOLOGY *with Clinical, Anatomical and Technical Supplements.* *By Ben W. Lichtenstein. W. B. Saunders Company, Philadelphia and London.* $9.50. xviii + 474 pp.; ill. 1949.

In this new textbook of neuropathology, the author has given a very good account of general disease processes within the nervous system and of pathological methods of detecting them, as well as excellent statements concerning clinical syndromes and disease entities. Since clinical neurological literature is so overburdened with syndromes named for their discoverers, it is a blessing to have a book in which all these syndromes, some of them most obscure, are brought together and given clinical and pathological delineation. There is an excellent supplement on neuropathological technics. Not the least helpful aspect of this textbook is the beautiful photography of both gross and microscopic sections. It is as good as that seen in prewar German publications and enhances the value of the text not a little. This should be a very useful book for students and practitioners as well as for professional pathologists.

WENDELL MUNCIE

LABORATORY MANUAL IN ANATOMY AND PHYSIOLOGY. *Second Edition.*

By Caroline E. Stackpole and Lulia C. Leavell. The Macmillan Company, New York. $2.00 (paper). viii + 216 pp.; ill. 1948.

This elementary manual is planned to accompany the *Textbook of Anatomy and Physiology* by Kimber, Gray, Stackpole, and Leavell.

DAVID B. TYLER

ANIMAL PHYSIOLOGY

PHYSIOLOGIE DE L'INSECTE: *Les Grandes Fonctions, le Comportement, Ecophysiologie.*

By Rémy Chauvin. L'Institut National de la Recherche Agronomique, Paris. 2500 fr. 619 pp.; ill. 1949.

To write a treatise in a young and rapidly expanding field is a tremendous task for any one person. This is particularly true in insect physiology. Since the publication of the *Principles of Insect Physiology* by Wigglesworth, eleven years ago, data on the physiology, chemistry, and pharmacology of insects have been accumulating at an ever increasing rate, due in large measure to the need for and the development of more effective insecticides. To assemble the scattered material, to integrate it with the more classical studies on insects and the vertebrates, and to present it in readable form to so diverse a group as students, teachers, and research workers who may be entomologists, physiologists, chemists, or insecticide manufacturers is indeed a task. Chauvin has done this in most admirable fashion.

The contents by chapters are as follows: the integument, molting and metamorphosis, digestion and nutrition, excretion, circulation (including the fat body and oenocytes), respiration, nervous system (including locomotion, reflexes, and taxes), sense organs and behavior, and growth and reproduction. The endocrines and intermediary metabolism are discussed under the processes in which they are involved in the various organ systems, e.g., hormonal control of color change under integumentary pigments, metabolic changes during metamorphosis under molting. Some of the less easily classifiable material, such as luminescence and the chemical constitution of the insect, is fitted in smoothly in not inappropriate places.

Typically, each chapter is introduced by a short, general description of the morphology of the organ system. This is followed by the detailed chemistry and physiology of the individual processes and parts of the system. An up to date bibliography ends each chapter. The strength of the book is greatly enhanced in two ways, in the opinion of the reviewer: first, more attention is given to methods and to biochemistry than is usual in a general physiology textbook; second, in each subsection a general statement is made and followed by typical examples in detail, usually in ordinal sequence. For example, the discussion of the osmotic pressure of the blood opens with two paragraphs descriptive of methods of determining the pressure in small volumes of liquid. This is followed by the general statement that the insect's osmotic pressure is generally higher than that of the mammal, with a paragraph each devoted to examples from five orders. Finally, with suitable figures and graphs the relation of osmotic pressure to the biotope and the details of osmotic regulation in three well known groups (Sigara, Culicids, Aedes detritus and Chironomids) are presented.

As would be expected in an undertaking of this magnitude, some chapters are exceedingly good, e.g., those on digestion and circulation, while others are less so, e.g., those on respiration and the nervous system. However, every aspect of the subject appears to be mentioned, and all of the material is clearly and concisely presented and well documented (e.g., chapter III, on digestion, contains 24 tables, 8 figures, and 258 references). This is a most welcome and valuable book, one which should prove to be of great usefulness to entomologists and physiologists alike.

GEORGE A. EDWARDS

TEXTBOOK OF PHYSIOLOGY. *Tenth Edition.*

By William D. Zoethout and W. W. Tuttle. The C. V. Mosby Company, St. Louis. $4.75. 710 pp. + 6 plates; text ill. 1949.

This 34-year-old elementary textbook of physiology requires little introduction. The 10th edition is essentially the same as the 9th, reviewed earlier in this Journal (Q. R. B., *23:* 259. 1948). Additonal topics have been covered in this edition by the addition of some paragraphs on sleep, energy balance, water content, body temperature regulation, blood sedimentation rate, lymph glands, isotopes, and suppressor areas of the cerebrum. The general style and format are similar to those of earlier editions.

DAVID B. TYLER

VITAMINS AND HORMONES. *Advances in Research and Applications. Volume VI.*

Edited by Robert S. Harris and Kenneth V. Thimann. Academic Press, New York. $7.80. xii + 435 pp. 1948.

The current volume of this valuable series contains eight reviews, two of which should be of rather general interest to theoretical biologists, namely, The B Vitamins as Plant Hormones (James and Harriet Bonner),

and Vitamins in Microorganisms (J. M. Van Lanen and Fred W. Tanner). The Bonners have done a very satisfying piece of work in presenting data which give us "a partial understanding of the vitamin economy in the higher plant, and of the basic and general role of vitamins in the plant." This development has been made possible by the application of plant tissue culture techniques, since the higher plant, unlike the higher animals, is in general able to synthesize its own vitamins, making elucidation of the part played by vitamins by simple depletion experiments not possible with plants. These studies have revealed that certain of the B vitamins function in the plant as hormones.

The similarities in many of the biochemical processes of highly varied forms of life are further emphasized by Van Lanen and Tanner's review. "Conspicuous as a result of the progress of the last decade has been the growing realization that the vitamins have a general rather than a particular significance in biology. Particularly striking . . . has been the parallelism between factors essential in animal nutrition and those required for the growth of microorganisms. . . . Microbiology is certain to occupy a pivotal position in furthering our understanding of essential nutritional factors. . . . Aside from theoretical considerations, the elaboration of vitamins by microorganisms has become of increasing commercial importance. . . . On the basis of their sporadic distribution in microorganisms as well as their general lack of essentiality, ascorbic acid and the fat-soluble vitamins are readily separable from the regularly accepted members of the B complex. . . . Vitamins of the B group are universally distributed in microorganisms and occur there at a level appreciably above that commonly found in other biological specimens. Likewise, the majority of microbial species are capable of synthesizing these substances, in many instances making use of only the simpler forms of carbon and nitrogen." There are suggestions of correlations of anabolic and catabolic processes with vitamin formation and content.

The article on The Assessment of Human Nutriture (H. M. Sinclair) deserves the thoughtful consideration of the medical profession. This thorough and refreshing critique of attempts to evaluate human nutrition is forced to conclude that "man is a neglected animal." The volume also includes articles on the Chemistry of Pteroylglutamic Acid and Related Compounds (Brian L. Hutchings and John H. Mowat); Vitamin K (Henrik Dam); The Nutritional requirements of the Cotton Rat and Hamster (B. S. Schweigert); and Vitamins as Pharmacological Agents (Hans Molitor and Gladys Emerson).

E. C. Kendall has contributed a substantial 50 pages on The Influence of the Adrenal Cortex on the Metabolism of Water and Electrolytes, which is presented with a commendable background sketch of the normal distribution of electrolytes and some of the functional influences to which they are subject. In consequence, Kendall has been able to develop a more fundamental and rational approach than is sometimes shown by devotees of adrenal physiology. This review closes with a reference to a mechanism for the transport of ions across cell membranes. "The nature of this mechanism is as elusive as a gremlin, but when it is understood we shall know how a simple group on the steroid nucleus confers physiological freedom from domination by electrolytes."

It is a commentary on the economics of science in our time that of the ten American contributors only the Bonners hold appointments from an academic institution.

EVELYN HOWARD

VITAMINS AND HORMONES. *Advances in Research and Applications. Volume VII.*
Edited by Robert S. Harris and Kenneth V. Thimann. Academic Press, Inc., New York, N. Y. $7.80.
xii + 488 pp. 1949.

Twelve reviews, allotted seven and five to vitamins and hormones, respectively, illustrate in their several ways the varied functions of this type of essay: instruction, admonition, and goad.

Scarborough and Bacharach on vitamin P steer a wary course between those who deal with "vitamin P and chemical structure" and those who deny its existence. They show that a good part of the confusion surrounding this vitamin results from a failure to distinguish between capillary fragility and capillary permeability, and that the most unequivocal effects of the vitamin are on the former. In discussing the provitamins A, Zechmeister shows that variation in stereochemical arrangement alone may give a change in physiological activity of the same magnitude as that caused by a significant alteration in chemical structure. A stereochemical basis for the conversion of the provitamins to vitamin A is suggested. Factual data for the vitamin requirements of the guinea pig and the rat, respectively, supplement reviews in previous volumes of this series on the requirements of other laboratory animals. The role of thiamin in tissue metabolic reactions is reviewed by Jansen (Holland), and the basic flaw in the pellagra-causing maize diet is shown to be the absence of tryptophane (Krehl). C. M. McCay has written, in Diet and the Aged, an interesting and original review. The philosophy that "assumes little responsibility for (aged) citizens outside the family circle" does not appear to be limited to the Island of Okinawa, and the finest laboratories for the study of dietary deficiencies continue to be the various institutions of moral correction, and the asylums for the aged and insane.

Two excellent reviews of the chemistry of pituitary and other gonadotrophins (Li) and luteotrophin (White) emphasize the considerable body of new work in these fields. On the other hand, the posterior pitui-

tary principles have provided a brisk pharmacology but altogether stagnant chemistry (Stehle). Articles on alloxan diabetes (Cabell Bailey) and infrared steroid spectrometry (Norman Jones and Dobriner) complete an interesting and valuable volume.

A few interpretations and misprints challenge the acuity of the reviewer. It should be emphasized that the figures (p. 99) for sedimentation of thiamine pyrophosphate enzymes refer rather to the particles with which the enzymes are associated than to the enzyme proteins themselves. A misplaced decimal gives pig FSH 44 per cent of hexosamine (p. 235). The same hormone gives resumption (not resorption) of follicular growth (p. 229).

H. N. CATCHPOLE

PHYSIOLOGY IN DISEASES OF THE HEART AND LUNGS. *By M. D. Altschule. Harvard University Press, Cambridge.* $5.00. xvi + 368 pp. 1949.

Although the author, in writing this excellent monograph, had in mind the needs of third and fourth year medical students, the book will undoubtedly be of great value also to those who are actively engaged in medical teaching, as well as to the more serious students of the subject. The teacher will find this an excellent source book for the preparation of lectures, while to the research worker it will be of particular value because of the completeness of the bibliography. Probably many investigators will take issue with Altschule on some of the interpretations he has made of their data; but, as the author points out, treatment of the data will also undergo revision in the future and by others.

The subject matter is treated in 12 different chapters wherein Altschule critically reviews the available data dealing with Chronic Cardiac Decompensation, Acute Pulmonary Edema, Cardiac Asthma, Angina Pectoris, Myocardial Infarction, Cardiac Arrhythmias, Pericarditis, Congenital and Acquired Cardiac Defects, Pulmonary Fibrosis, Chronic Pulmonary Emphysema, Bronchial Asthma, Pleural Effusion, and Pneumothorax and Pneumonia. The book is excellently written and well organized and can be recommended as a valuable addition to the library of any physiologist, physician, or investigator concerned with these problems.

DAVID B. TYLER

HEMOLYSIS AND RELATED PHENOMENA. *By Eric Ponder. Grune & Stratton, New York.* $10.00. viii + 398 pp.; ill. 1948.

It is now some fifteen years since the publication of a previous monograph on the erythrocyte by this author. There are many physiologists who have felt that a careful study of hemolytic phenomena would produce results of the greatest theoretical importance in understanding the cell surface. The years have passed and the work has been continued with commendable diligence. Therefore, it is somewhat disappointing to find that the goal of a real understanding of the cell surface seems as far away as before. Such a situation is not to be taken as implying any criticism of the author. On the contrary, the experimental data in this field are so voluminous and in several cases so reproducible that it is obvious that biological workers have passed beyond the present limits of our knowledge of the physics and chemistry of surfaces and of colloids. What would seem needed now is a greatly expanded program of research in colloid physics.

The first three chapters of the book deal with introductory ideas and with changes of shape either with or without volume changes. These chapters are largely an account of work which was completed by 1934. Chapter IV is on the cytochemistry and architecture of the erythrocyte. It includes much valuable tabular material on the chemical properties of the red cell and has a thought-provoking discussion of the state of hemoglobin in the cell under normal and sickling conditions. Chapter V is on the kinetics of hemolysis. Although students of chemical reaction kinetics may be somewhat dismayed by the rather complex formulations for lysis, it remains to be demonstrated that such formulations can be made more simply. There is a fairly thorough discussion of prolytic ion changes in cells, but the treatment of the cation permeability of cells is rather fragmentary. The author states that the subject of permeability is not within the scope of the book, but it is difficult to see how a thorough discussion of cation permeability, a subject previously much in dispute, can be omitted if one is to understand hemolysis. Chapter VI deals with the inhibition and acceleration of hemolysis. It contains a very detailed account of the effects of a large number of biologically important substances on hemolysis. It is here that it is particularly clear how difficult it will be to formulate ideas of surface structure that will explain the diversity of phenomena observed. The last chapter is a review of hemolysis in vivo and deals largely with clinical phenomena.

L. J. MULLINS

RECENT PROGRESS IN HORMONE RESEARCH: *The Proceedings of the Laurentian Hormone Conference. Volume IV.*

Edited by Gregory Pincus. Academic Press, New York. $8.80. viii + 529 pp.; ill. 1949.

Although the subject matter of one conference may be insufficient to indicate a trend, it is interesting that fully three quarters of the papers given at the 1948 Laurentian Hormone Conference showed a direct or implicit involvement with topics of clinical research,

and several with the growing use of the isotopic method in tracing, for example, changes in fat and carbohydrate metabolism (Stettin) or in the distribution of iodine (Keating and Albert; Seidlin). The human being as a hormone converter is represented in papers on estrogen and progesterone metabolism, in which interest continues unabated (Marrian; Heard and Saffron; Segaloff), while Samuels discusses the conversion of androgens at the tissue level. "Man a Machine" emerges from the extensive studies of the Harvard School (see diagram, p. 281); and equally, "Man not a Machine" (not an adding machine, at least) from those of the Worcester Foundation and the Allen Memorial Institute.

The somewhat perennial topic of antihormones brought out a discussion that turned largely on the concept of "pure hormones"—a concept to which the principles expounded by Pirie some time ago (*Biol. Rev.*, 15: 377. 1940) might profitably be applied. Stevenson described the remarkable fat rats of Yale which, like their literary forebear who:

"grew his little paunch as fat
As that of Doctor Luther,"

also seem to have had difficulties with their internal combustion. An urbane discourse, The Pancreas as Guardian of the Liver, presented a superior level concept, of the sort which, it seems, it should be a general objective of this kind of Conference to evoke.

Discussion of the papers provided a spirited commentary, and this volume, as a whole, is a valuable addition to endocrine literature. The printer's devil has evidently been seeing too many psychoanalytical movies; he turns up (p. 146) with a "prostatic group attached to a protein."

Contents: G. F. Marrian, Some Aspects of Progesterone Metabolism; R. D. H. Heard, The Metabolism of the Estrogens, Part I; R. D. H. Heard and J. C. Saffran, The Metabolism of the Estrogens, Part II; Leo T. Samuels, The Metabolism of Androgens by Tissues; Albert Segaloff, The Metabolism of Estrogens with Particular Emphasis on Clinical Aspects of Physiology and Function of Ovarian Hormones; James H. Leathem, The Antihormone Problem in Endocrine Therapy; Abraham White, Integration of the Effects of Adrenal Cortical, Thyroid and Growth Hormones in Fasting Metabolism; Dewitt Stettin, Jr., The Alterations in Metabolism Incident to Administration of Insulin, Adrenalin and Thyroid Substances, Studied with the Aid of Isotopes; C. H. Best, The Pancreas as Guardian of the Liver; George W. Thorn and Peter H. Forsham, Metabolic Changes in Man Following Adrenal and Pituitary Hormone Administration; Gregory Pincus, Hudson Hoagland, Harry Freeman and Fred Elmadjian, Adrenal Function in Mental Disease; R. A. Cleghorn and B. F. Graham, Manifestations of Altered Autonomic and Humoral Function in Psychoneuroses; James A. F. Stevenson, Effects of Hypothalamic Lesions on Water and Energy Metabolism in the Rat; Rulon W. Rawson and William L. Money, Physiologic Reactions of the Thyroid Stimulating Hormone; F. Raymond Keating, Jr., and A. Albert, The Metabolism of Iodine in Man as Disclosed with the Use of Radioiodine; S. M. Seidlin, Radioiodine as a Diagnostic and Therapeutic Tool in Clinical Medicine.

H. R. CATCHPOLE

THE CYCLE IN THE GAMBEL SPARROW.
By Barbara D. Blanchard and Mary M. Erickson. University of California Press, Berkeley and Los Angeles. $1.50 (paper). iv + Pp. 255–318 + 1 chart; ill. 1949.

The senior author of this paper is well known for her work on two forms related to the Gambel sparrow, *Zonotrichia leucophrys nuttali* and *Z. l. pugetensis*. The race, *Z. l. gambeli*, studied in the present publication is a winter resident in California and migrates north to British Columbia and Alaska to breed. As in the previous study, the cyclic histological changes in the male gonads were extensively studied during the period of winter residence and the various stages of recrudescence were compared and correlated with the activities of the birds. Leydig cells were found to be absent from specimens collected between September and early January. Their subsequent appearance preceded by four weeks any visible change in the tubules; it is emphasized that their appearance forms the first indication of testicular recrudescence. These cells undergo an enormous increase in number up to the time when mature sperms appear; it was calculated that the total volume of glandular intertubular tissue was 130 times as great in the breeding testes as in gonads beginning to recrudesce. It is suggested that this parallel increase between Leydig cells and the resurgence of sexual behavior may be taken to indicate that they are the source of the male sex hormone.

The first appearance of the Leydig cells is designated as Stage 2. One bird at Davis was in Stage 2 on January 5; two others collected on the same day were still in the winter condition. On January 20, of seven specimens sectioned, one was in Stage 3, one in Stage 1, and five in Stage 2. At Santa Barbara the earliest date for Stage 2 occurred on January 8. Comparison of the initial date for these changes with external factors of day length, temperature, humidity, and solar energy leads the authors to conclude that such factors play insignificant roles, if any at all, in the physiological processes of testis recrudescence and that recrudescence must perforce be an inherent rhythm. This conclusion is similar to the one reached by the senior author in her former study.

Since so much experimental evidence has accumulated to show that manipulation of light does influence

the gonad cycle, it will be of great interest to discover wherein lies the discrepancy between experimental birds and those exposed to natural conditions. Although the effect of increasing light is denied in the present paper, the argument is not entirely convincing. It is pointed out that the average increase in light was only 0.9 minutes per day from the time of the winter solstice through January, and that from December 22 to January 5 the absolute increase was of the order of 6 minutes, that the majority of days during this period were cloudy, rainy, or otherwise obstructive to the total possible sunlight. The latter argument is certainly not valid, considering the fact that as little as 0.04 foot candles of illumination has been shown to cause some testicular activity. Even the darkest day has considerably more light than this. The 15-day interval with only a seemingly trifling increase in daylength might still be sufficient to initiate Stage 2. English sparrows on just a 10-hour day have been found to have dividing spermatogonia, a point well beyond the Stage 2 described here. Therefore, although photoperiodicity may not have as simple and direct an influence on gonad recrudescence in free wild birds as has been believed, it is still not a factor to be ruled out peremptorily without conclusive evidence to the contrary. The major weakness of this report lies in the evaluation of external environmental conditions. Otherwise it is an excellent and valuable contribution, one which taken together with the previous study provides considerable insight into the physiological ecology of closely related birds, and emphasizes once again that external morphology is not always a reliable criterion for distinguishing subtler and more important differences in physiology and behavior.

HENRI C. SEIBERT

THE ADRENAL CORTEX. *Annals of The New York Academy of Sciences, Volume 50, Article 6.*

By R. Gaunt, G. E. Bergner, J. S. L. Browne, H. W. Deane, R. I. Dorfman, W. J. Eversole, P. H. Forsham, Roy O. Greep, A. G. Hills, D. J. Ingle, E. C. Kendall, E. J. Kepler, L. A. Lewis, I. H. Page, G. Pincus, F. T. G. Prunty, G. Sayers, M. A. Sayers, G. W. Thorn, E. H. Venning, and G. W. Woolley. The New York Academy of Sciences, New York. $3.00 (paper). Pp. 509–678; ill. 1949.

This authoritative series of papers is the result of a conference on the adrenal cortex, held jointly by the New York Academy of Sciences and the New York Academy of Medicine, March 21 and 22, 1948. Introductory notes on the history of the adrenal cortical problem are presented by Robert Gaunt and J. W. Eversole. There follows a straightforward presentation of studies on pituitary-adrenal interrelationships by G. and M. Sayers, with evidence for an inverse relationship between the blood concentration of adrenal hormone and the pituitary output of adrenocorticotrophic hormone. E. C. Kendall discusses the difficult syntheses of the adrenal steroids, with their still unsatisfactory yields. Evidence that the biological properties of synthetic and natural 11-dehydrocorticosterone are nearly identical is presented by L. A. Lewis and I. H. Page, R. I. Dorfman, and E. H. Venning. A critical survey of representative methods for the bioassay of adrenal hormones is given by R. I. Dorfman.

D. J. Ingle surveys the role of the adrenal cortex in organic metabolism in his characteristically thoughtful manner. Ingle concludes that:

"The thinking of many of us in the adrenal field has become too rigidly channelized during the past few years. It is common to describe adrenal physiology in terms of electrolyte and organic metabolism as though they are completely unrelated functions, electrolyte metabolism being controlled by 11-desoxycorticosterone and organic metabolism being controlled by the C-11-oxygenated steroids. The story is not this simple . . . there is considerable overlapping of effects, and there is a great deal of evidence that there are basic relationships between the distribution of inorganic ions and the metabolism of organic compounds which relate to adrenal cortical functions. . . . We have spoken of end results as if they were the processes of action. We know none of the reactions into which the cortical hormones enter to bring about their metabolic effects. . . . Not all of the effects of the cortical hormones upon the viability and vigor of the animal can be defined in terms of what is now known of the metabolic effects of these hormones. . . . The most important and remarkable advances in the adrenal field have been the isolation, identification and synthesis of several biologically active compounds. . . . Now the new techniques of enzymology and isotope chemistry may be the tools required to probe into the processes by which the cortical hormones produce their effects. In addition to techniques, new and broader concepts are needed. I hope there will remain a place for physiologists . . . who will, at appropriate intervals, remind the chemist that the organism functions as a whole."

R. O. Greep and H. W. Deane, in discussing the cytology and cytochemistry of the adrenal cortex, summarize interesting evidence against the frequently reiterated view that the cells of the cortex are ordinarily undergoing periphero-central migration. The production of cortical tumors following gonadectomy in mice is described by G. W. Woolley. Data on the urinary excretion of corticoids and 17-ketosteroids are presented by E. H. Venning and J. S. L. Browne. These two groups of urinary metabolites are presumed to represent different adrenal functions, and, from their excretion rates under various conditions, it is suggested that these functions may vary independently of one another. Gregory Pincus discusses adrenal cortical function in stress as the beginnings of a systematic analysis of mental disease in terms of hormonal dysfunction. Clinical studies in Addison's disease are presented by G. W. Thorn and others, and Cushing's disease is discussed by E. J. Kepler. Altogether, the volume is a stimulating presentation of a considerable

range of contemporary work on the ubiquitous adrenal.

EVELYN HOWARD

LE SYSTÈME NERVEUX SYMPATHIQUE. *L'Avenir de la Science, Number 29.*

By Paul Chauchard. Gallimard, Paris. 490 fr. (paper). 364 pp. 1949.

In this book the author describes the sympathetic nervous system along broad lines and in a manner characterized chiefly by lack of interpretative inhibition. The first part contains, in addition to a short historical chapter, an anatomical account and a description of general function and pharmacology. The second part is devoted to internal sympathetic mechanisms, considering bioelectric, chemical, and physical phenomena. Sympathetic regulation of organic function and its maladjustments are covered in the last part. Some of the interpretations are far from general acceptance, at least among scientists who rate disciplined thinking a virtue. The inclusion of motor cells in dorsal root ganglia is bound to disturb anatomists, and few physiologists will be comforted by sympathetic reflexes mediated, partly antidromically, over separate branches of the axon of a single cell. Such conceptions unfortunately characterize the book. The few illustrations are poorly drawn. The bibliography, admittedly not complete, contains only 26 items, mostly general in nature. This book offers little or nothing to the serious student of the sympathetic nervous system.

F. N. LOW

ANIMAL NUTRITION

TRACE ELEMENTS IN FOOD.

By G. W. Monier-Williams. John Wiley & Sons, New York. $6.00. viii + 511 pp.; ill. 1949.

The author is in charge of chemical researches in foods in the Ministry of Health, England. His book contains 28 chapters, and some discussion of 32 elements. It is, however, not well planned and has serious defects. The term trace elements has come to be used to designate those elements which are of metabolic significance in normal plant and animal metabolism. They are essential nutrients. The author includes discussion of these, but gives fully as much space to a consideration of elements which frequently occur in small amounts in foods, and which, so far as is known, are foreign and poisonous materials, primarily of interest to the food inspector and toxicologist. Either group of elements alone might well be treated in a book of this size, but they should not be listed indiscriminately in one volume. The treatment accorded the elements is very uneven. Twenty-five per cent of the book is devoted to copper, lead, and zinc. Almost as much space is given to tin, arsenic, antimony, selenium, and iron. Other elements are quite inadequately discussed. An example is cobalt, for which there is but one reference to any publication as recent as 1944. The bibliographic references to older literature will be useful, but for recent publications the reader will have to seek elsewhere. Much space is devoted to analytical methods for the quantitative estimation of certain elements. It is a mistake to try to include discussions of biological significance, toxicology, and analytical methods for so many elements in a volume of this size.

E. V. MCCOLLUM

TOMORROW'S FOOD. *The Coming Revolution in Nutrition.*

By James Rorty and N. Philip Norman; foreword by Stuart Chase. Prentice-Hall, New York. $3.50. xiv + 258 pp. 1947.

This is a thought-provoking book which everyone should read, for everyone must eat. Again and again the authors, one of whom is a journalist and the other a physician, call attention to the sobering fact that Americans are not eating the most healthful food and that this is because of various reasons—one, and most important, the over-processing of grains for the manufacturing of flour and various processed breakfast foods. They also show that commercial handling practices destroy much of the natural vitamin content as well as other health-giving food qualities. They emphasize the nutritional inadequacies of the so-called "enrichment" of foods. Recalling the campaign of Harvey W. Wiley, who championed the food needs of American consumers, Rorty and Norman show that the time is already ripe for another Wiley, a man with sufficient courage to defy the commercialism of food processing and advertising. The authors complain that the public does not learn through magazines all that it might about nutrition, because of the domination of the editorial policies of periodicals by the advertisers. They also rightly emphasize the strength of custom in determining food habits and practices, and the fact that this is not entirely dependent upon commercialism and advertising. This is exemplified in illiterate Asia by practically universal milling of rice by all the natives in all rice-growing regions, a practice which constitutes a nutritional impoverishment even though hand milling is not as deleterious as machine processing. The two appendices, How to Eat Sensibly without Vitamin Charts, and Bibliography of Recommended Books, are useful adjuncts.

ROBERT L. PENDLETON

OUTLINES OF FOOD TECHNOLOGY. *Second Edition.*

By Harry W. von Loesecke. Reinhold Publishing Corporation, New York. $7.50. viii + 585 pp.; ill. 1949.

The author has included a surprising amount of information on the preparation, handling, and processing of fruits, vegetables, dairy products, meats, poultry, fish, shellfish, grains, fats, oils, sugars, starches, nuts, spices, relishes, essential oils and extracts, beverages, confectionery, jams, jellies, preserves, and certified dyes. The discussions cover raw materials, equipment, machinery, packaging, preserving, freezing, storing, and marketing. The author is a chemist in the U. S. Department of Agriculture, and is obviously thoroughly familiar with his subject. He acknowledges the assistance of 14 men whose names are familiar to all who know anything about food technology. The book is to be highly recommended.

E. V. McCollum

Diet in Relation to Reproduction and the Viability of the Young. *Part I. Rats and Other Laboratory Animals. Commonwealth Bureau of Animal Nutrition. Technical Communication Number 16.*

By F. C. Russell; with a Foreword by I. Leitch. Commonwealth Bureau of Animal Nutrition, Rowett Institute, Bucksburn, Aberdeen, Scotland. 6s. (paper). 99 pp.; ill. 1948.

It is pointed out that the earnings of animal husbandry are seriously reduced by losses due to inefficiency of the breeding stock, to poor lactation, and to low vitality of the young. There are many evidences that inadequate dietaries may be implicated. Since adequately planned and controlled studies for clarifying the problems involved are not available for farm animals, the authors undertook to assemble all available data from laboratory animal experiments which have a bearing on the subject, and to interpret these data in the hope that such a study might shed light on problems of reproduction and the rearing of young in animal husbandry. They first reviewed this field of inquiry fifteen years ago. The present study was based upon an examination of all abstracts in volumes 1–17 (1931–1948) of *Nutrition Abstracts and Reviews*. Stock diets, food consumption and energy requirements, protein, carbohydrate, calcium, phosphorus, vitamin D, magnesium, iodine, iron, copper, manganese, sodium, chlorine, potassium, aluminum, boron, fluorine, selenium, essential fatty acids and fat, vitamin A and carotene, vitamins E and K and the "grass juice factor," vitamin C, the B-complex components and choline are examined in their possible relation to fertility and viability of young. There is an interesting summary, a bibliography of 414 titles, and an index. This thorough inquiry into the meaning of recorded experiments with laboratory animals with reference to reproduction, etc., will be invaluable to all nutrition investigators and animal husbandmen.

E. V. McCollum

BIOPHYSICS

Applied Biophysics. *Survey of Physical Methods Used in Medicine. A Symposium.*

Edited by N. Howard-Jones. Chemical Publishing Company, Brooklyn. $6.75. viii + 293 pp.; ill. 1949.

A symposium of articles on physical methods used in medicine, previously published in the British Medical Bulletin, and written by well known medical physicists of England, this small volume consists of terse summaries of several diverse and important fields to which physicists have contributed. Except for the articles on drug action and the mechanics of brain injuries, the book deals primarily with applications of electronics, heat, and ionizing radiation to diagnosis and therapy of cancer and related diseases.

Titus C. Evans

Radiology Physics. *An Introductory Course for Medical or Premedical Students and for All Radiologists. Second Edition.*

By John Kellock Robertson. D. Van Nostrand Company, New York, Toronto and London. $5.00. xviii + 323 pp.; ill. 1948.

This second edition is a revision of a very readable and non-mathematical introduction to the physical principles underlying the use of x-ray generators and radium applicators. The most evident additions are terse summaries of principles involved in atomic energy and in super-voltage particle accelerators. The book begins with a review of pertinent principles of electricity and magnetism. This is followed by illustrations of these principles in the generation and control of high voltage to produce ionizing radiation. The most practical part of the book, from the standpoint of the radiation-biologist, is the comprehensive discussion of the properties of x-rays and their interaction with matter. The last part of the book deals with radioactivity, transmutation, and uranium fission.

Titus C. Evans

Infrared Determination of Organic Structures.

By H. M. Randall, R. G. Fowler, Nelson Fuson, and J. R. Dangl. D. Van Nostrand Company, Inc., Toronto, New York, London. $10.00. v + 239 pp.; ill.; 354 plates. 1949.

Spectroscopy, using visible and ultraviolet light sources, has long been a useful means to the characterization of biologically important compounds. Infrared spectroscopy has not been developed to the same extent because of inadequate sources and recording devices, although the chemical industries have successfully employed available instruments for the qualitative and

quantitative identification of compounds and mixtures of compounds. The authors, realizing the need for detailed information in this increasingly important field, have compiled a mass of data, much of it from their own researches, into a form useful for those who would employ infrared spectroscopy in the determination and identification of molecular structure.

The book may be divided roughly into three major aspects which, however, are not arranged consecutively as to chapters. The first considers the possibilities and limitations of infrared spectroscopy in chemical analysis, the instruments, techniques, and practical applications, and the methods of recognizing and interpreting specific structure groups. The second aspect, covering two chapters, is concerned with cataloguing the information which deals with the "empirical structural assignment for the double-bond region" and the "structural assignment for theoretically analyzed molecules." Some 600 double-bond compounds are catalogued for absorption assignment in the 6 micron region, and some 350 molecules are theoretically analyzed as a point of departure for further investigations. The remainder of the book lists half-tone absorption spectra of 355 organic compounds.

As the authors point out, the data presented deal largely with compounds of the aliphatic and phenyl-substituted aliphatic families, and represent a portion of their contribution to problems of penicillin structure and synthesis. The compounds discussed, therefore, are of limited scope. The usefulness of the book goes beyond this, however, for it provides a basis for spectroscopic work on a variety of compounds and by a variety of workers.

C. P. SWANSON

BIOCHEMISTRY

ANNUAL REVIEW OF BIOCHEMISTRY. *Volume XVIII. Edited by J. Murray Luck, Hubert S. Loring and Gordon Mackinney. Annual Reviews, Stanford, California.* $6.00. x + 739 pp. 1949.

The hardy perennial of summarization in the vast field of biochemistry continues to fulfill its function in this, the 18th volume of the series, in which reference is made certainly to most of the important papers published over a period of approximately one year. The editors have maintained the standards set in previous volumes. They have selected significant chapter headings, keynoting the broad topics for review. They have been able generally to attract eminently competent authors. To quote from the Preface: "While the writing of reviews of one sort or another is becoming a literary and intellectual experience which falls to the lot of almost every scientist sooner or later there is nothing in the accumulated experience that makes the task easier. In these *Reviews* especially it is admittedly arduous. A strenuous effort is made to maintain them at a critical level." As to the necessity of transferring some special subjects of a biochemical nature to other members of the family of *Annual Reviews*, the editors have reassured the reader as follows: "It is, however, our hope and confident expectation that all investigations of a fundamental character, whether the subject of research be a plant, an animal, or a microorganism, will continue to find their place in the *Annual Review of Biochemistry*."

The topics reviewed and the respective authors are: Biological Oxidations (P. W. Preisler and F. E. Hunter, Jr.); Proteolytic Enzymes (E. L. Smith); Nonoxidative, Nonproteolytic Enzymes (K. Myrbäck); Carbohydrate Chemistry (D. J. Bell); Chemistry of the Lipids (J. A. Lovern); Chemistry of Amino Acids and Proteins (H. P. Lundgren and W. H. Ward); Nucleoproteins, Nucleic Acids, and Derived Substances (J. N. Davidson); Metabolism of the Lipids (A. L. Lehninger); Chemistry of Neoplastic Tissue (E. Boyland); Metabolism of Proteins and Amino Acids (A. Neuberger); Intermediary Metabolism of Phosphorus Compounds (F. Lipmann and N. O. Kaplan); Carbohydrate Metabolism (H. G. Wood and V. Lorber); Mineral Metabolism (Fluorine and Other Trace Elements) (F. J. McClure); Chemistry of the Hormones (A. Wettstein and F. Benz); Fat Soluble Vitamins (P. L. Harris); Water Soluble Vitamins (E. L. R. Stokstad and T. H. Jukes); Nutrition (A. Keys); Metabolic Inhibitors (R. J. Winzler); Chemistry of Antibiotics (O. Wintersteiner and J. D. Dutcher); Insect Biochemistry (V. B. Wigglesworth); Nitrogenous Constituents of Plants (A. G. McCalla); Organic Acids of Plants (T. A. Bennet-Clark); Mineral Nutrition of Plants (C. H. Wadleigh). There are adequate author and subject indexes.

LESLIE HELLERMAN

INTRODUCTION TO PHYSIOLOGICAL AND PATHOLOGICAL CHEMISTRY. *With Laboratory Experiments. Third Edition.*

By L. Earle Arnow, with an introduction by Katharine J. Densford. The C. V. Mosby Company, St. Louis. $4.00. iv + 595 pp.; ill. 1949.

This is a highly condensed presentation of such subjects as organic chemistry, biochemistry, nutrition, and clinical laboratory chemistry. The book has been written for the training of nurses, and it is probably very adequate for this purpose. One must regret that such a training course has to be so condensed, and that so little basic information can be presented. The book is not suitable for the training of biologists.

L. J. MULLINS

ADVANCES IN CARBOHYDRATE CHEMISTRY. *Volume 4. Edited by W. W. Pigman and M. L. Wolfrom. Academic Press, New York.* $7.80. x + 378 pp. 1949.

The fourth volume of this series maintains the high standard of the preceding three volumes. It contains 10 chapters that cover various specialized aspects of carbohydrate chemistry.

The first article, The Structure and Configuration of Sucrose (I. Levi and C. B. Purves), is a masterly review of the chemical work on sucrose since the early nineteenth century, tracing the work to the present time, when knowledge of the configuration of this sugar is practically complete. Also included is information concerning the biochemical synthesis of sucrose.

The second contribution, Blood Group Polysaccharides (H. G. Bray and M. Stacey), deals with blood group substances. These authors have summarized the efforts of the last two decades to elucidate the chemical nature of blood group substances, which are largely carbohydrate in nature and of the mucoprotein type.

A detailed account of Apiose and the Glycosides of the Parsley Plant is given by C. S. Hudson. The knowledge of parsley glycosides is treated historically, and their proof of structure is discussed in detail. C. Neuberg, in an article entitled Biochemical Reduction at the Expense of Sugars, is concerned with the phytochemical reductions of sugars by various classes of compounds, such as aldehydes, ketones, diketones, quinones, and others.

An informative article on the Acetylated Nitriles of Aldonic Acids and their Degradation has been prepared by V. Deulofeu. It deals chiefly with the Wohl degradation procedure, in its different variations and modifications.

Wood Saccharification (E. E. Harris) is an interesting discussion of the production of sugar from wood waste. This process has claimed the attention of chemists for many years. J. Boeseken, in his contribution on The Use of Boric Acid for the Determination of the Configuration of Carbohydrates, has reviewed the work on the interaction of boric acid with sugars, and points out the valuable knowledge that has been gained from these reactions regarding the configuration of carbohydrates. R. Lohmar and R. M. Goepp, Jr., in The Hexitols and their Derivatives, give an account of all the known sugar alcohols, their occurrence, preparation, and physical and chemical properties.

The article Plant Gums and Mucilages (J. K. N. Jones and F. Smith) is an excellent summary of the complicated structure of these compounds. The knowledge gained in that subject is chiefly the result of the efforts of the English investigators, Haworth, Hirst, Smith, and Jones, who have used the methylation procedure.

The last article, one on the Utilization of Sucrose (L. F. Wiggins), is concerned with processes for converting sucrose into compounds which can be used for industrial purposes.

Like the previous volumes of the series, this one is international in scope. Of the 10 articles, three contributions have come from England, one from Canada, one from Holland, one from Argentina, and four from the United States.

W. Z. Hassid

Hematin Compounds and Bile Pigments. *Their Constitution, Metabolism, and Function.* *By R. Lemberg and J. W. Legge. Interscience Publishers, New York and London.* $15.00. xxvi + 749 pp.; ill. 1949.

This is a welcome and important addition to the bibliographic literature of biochemistry. The authors have incorporated within their domain the molecular, physical, and biological chemical properties of and relations among the porphyrins, bile pigments, hematin compounds, hemoglobins, and other metalloporphyrinoproteins, including hematin enzymes such as cytochromes, catalase, and peroxidase. Withal, they have contrived the miracle of comprehensiveness coupled with critical and discriminating analysis and treatment of numerous and diverse topics. Several of the fields under review naturally are in flux, and some of the material is controversial. Such material seems to have been treated with reasonable objectivity and fairness.

With satisfactory clarity the authors have referred throughout to the contributions afforded by the use of indispensable physical chemical approaches that have illuminated much of the subject matter. The principal methods include spectrophotometry, potentiometry, and magnetochemistry. There is a useful preliminary chapter entitled Methods of Investigation, credited to J. P. Callaghan. Obviously, any success in the treatment of many aspects of the difficult material reviewed rests upon those structural studies of the porphyrin compounds that constitute one of the outstanding achievements of "classical" organic chemistry in the first half of this century. This underlying field perhaps was not intended to be a primary consideration in the present volume, but it may be stated that the authors' employment of pertinent structural data is adequate.

It is impracticable to discuss here in any detail the large number of related topics of practical and theoretical importance that constitute the meat of this treatise. The subject matter obviously is of interest to the biologist, who no doubt will approve the authors' respect for comparative biochemistry. The medical investigator will find many points of interest, including commentaries on methods of estimating hemoglobin, functional adaptation in mammalian respiration, bile pigment estimation and metabolism, etc. The chemist will be intrigued by what has been accomplished through penetrating application of appropriate physical chemical techniques to a problem in metallo-coordination stemming from biology. The enzyme specialist will enjoy the discussions of respiratory catalysts, and, as suggested by the authors, will consult the recent

papers by Britton Chance for the latest word on catalase and peroxidase.

The bibliography, comprising pages 655 through 726, contains some 3200 citations.

LESLIE HELLERMAN

PATHOLOGIE DES KOHLEHYDRATSTOFFWECHSELS.

By E. Frank. Benno Schwabe & Company, Basel; Grune & Stratton, New York. Fr. 24.–. 342 pp. + 7 plates; text ill. 1949.

This is a comprehensive and well arranged book, intended primarily for the diabetic patient. It has successfully brought together the theoretical aspects of diabetes and its clinical applications, with emphasis on the latter. The causes, symptoms, and treatment of the disease are discussed. A great deal of attention is devoted to food selection and diet, as well as to the function and use of insulin. The facts are presented in historical perspective, the discussions being based on the experimental data of various investigators in the field. On the whole, the subject is treated in a scholarly manner.

In spite of the conscious attempt on the part of the author to make his subject comprehensible to the layman by its simplicity, the abundant use of highly technical formulae and medical terminology makes it doubtful whether the patient can derive much benefit from the book. For this reason the reviewer is of the opinion that this work is more suitable as a physician's manual.

W. Z. HASSID

MICROBIOLOGY

JORDAN-BURROWS TEXTBOOK OF BACTERIOLOGY. *Fifteenth Edition.*

By William Burrows; with the collaboration of Francis Byron Gordon, Richard Janvier Porter and James William Moulder. W. B. Saunders Company, Philadelphia and London. $9.00. xx + 981 pp. + 4 charts; text ill. 1949.

The successive editions of this well-known book have provided a changing picture of the science of bacteriology for over 40 years. The current edition maintains the excellence and up-to-dateness of its predecessors. While a large portion of the volume is devoted to the classification, pathogenicity, etc., of the various forms, the inclusion of recent work on the genetics, cytology, physiology, and nutrition of bacteria and bacteriophages serves to draw the subject matter into closer relationship with similar studies on higher organisms. The chapter on bacterial variation, however, does not receive the attention which it deserves. Many of the important papers dealing with this topic are not cited, and the significance of the techniques of bacterial genetics, as they apply to physiology and variation, is largely passed over. Except for this, the volume gives its rather large subject a well balanced and comprehensive treatment.

C. P. SWANSON

HEALTH AND DISEASE

PEACE OR PESTILENCE. *Biological Warfare and How to Avoid It.*

By Theodor Rosebury. Whittlesey House, McGraw-Hill Book Company, New York, Toronto and London. $2.75. viii + 218 pp.; ill. 1949.

Peace or Pestilence is a clear and easy-reading appraisal of biological warfare (BW) which admirably succeeds in its prime purpose of stimulating and informing the general reader. The contents are divided roughly into three parts. The first portion, which presents a survey of bacteriology and its place in society, provides the background of scientific information necessary for the layman's understanding of the subject matter of BW treated in the succeeding chapters. Finally there are chapters devoted to discussions of the political and ethical problems raised by this potential weapon for mass destruction.

The manner of presenting the technical and scientific data is skillful. The reader is not surfeited with fact and detail, but rather is fed an economical modicum of scientific information that sustains his interest, while logically supplying the factual basis for understanding each succeeding phase of the problems discussed. The reviewer caught only a few, and these unimportant, errors of fact and misspellings. For example, the molecular weight of botulinal toxin quoted is too low, and the Waring *blendor* is spelled *blender*.

The style of writing is light but not superficial, and can serve as a good example of popular science writing by the scientist. It suffers only from the author's occasional inability to resist the temptation to turn a neat phrase. These slips result in a sacrifice of strict historical accuracy, or let an ineffective prejudice intrude into an otherwise worthy argument. They also offend the more well-informed and sensitive reader as examples of "being talked down to." Thus in emphasizing the enormity of present day warfare that does not limit the slaughter to the warrior, the author remarks "How old-fashioned the ancients were!" (p. 179). But this gives our ancestors too much credit. I am sure that the sacking of cities and indiscriminate slaughter of civil populations were acceptable military policy in ancient as well as recent times. In this regard our forefathers have set us no good example. Then the "average" congressman is disparaged in a way that cannot win that "average" congressman to the author's point of view (p. 146). In a book attempting an objective

study of a serious social problem, while maintaining a definite point of view, a slip of this sort is particularly unfortunate. Certainly a task the author has set himself is to convince the "average" congressman and those citizens of similar attitudes of the reasonableness and logic of the book's theses. This cannot be done by publicly announcing mistrust of the "average" congressman's intellectual capacity. As another example we note (p. 173) the author's reminder to the reader that the temperature of the blood of scientists is the same as that of other humans.

The subject of BW deserves the serious attention of all persons. International bodies concerned with maintaining the peace are duty bound to give the subject consideration. This book, as the lone recent and available discussion of BW, deserves reading by a wide public of both laymen and scientists. It has a genuine contribution to make to the understanding and thinking of any person with the least sense of social responsibility. One would, therefore, hope for widespread sale and discussion of the book.

The endorsement does not mean that the reviewer would agree with the author in all respects on matters of judgment and opinion. In a democracy any well-written and honest book on a subject of great social import, which promises to increase the public interest and knowledge, deserves the support of the critic.

And so now a few words of criticism. The practical difficulties of making BW an offensive weapon are not neglected by the author, but he feels confident that these difficulties will yield to science and ingenuity (p. 116), and so justifies his view that BW presents society with the choice of peace or pestilence. But in so rationalizing the title of the book the author has not consistently applied his logic. The potential destructiveness of BW can only be realized practically if defenses against it lag far behind. Logically, one can also appeal to science and ingenuity to overcome the practical difficulties of defense against BW. The author is inconsistent and weakens his cause by stating: "... defense against BW as a whole is pitiably weak, so weak that some of us, civilian or military, cannot find much comfort in its prospect." (p. 135).

The question of the potential offensive value of BW is important, because one must weigh its destructiveness relative to atomic warfare. Should we press for agreement among the nations not to use atomic weapons when the BW weapons remain uncontrolled? Can the nations afford not to agree on control of atomic fission until agreement on BW weapons is possible? Is the relative threat to humanity by atomic warfare greater than BW? *Peace and Pestilence* gives each type of weapon the same value. There is room for serious disagreement with this point of view. It is not entirely a matter, as suggested by the author, of the physicists being more afraid of the bacteria and the biologists more afraid of the atom. The principles of specific defense against BW are available from the sciences of immunology and epidemiology. There is no specific defense against the exploded atomic or H bomb. The nature of the long-term biological effect of using these diverse weapons on large populations is sufficiently different to give the biologist's fear of atomic fission the greater weight. If the nations do not in our generation agree to abandon warfare as an instrument of national policy, as a generation we will suffer the consequences of our folly, irrespective of the nature of the weapons used. But if atomic weapons are used the sins of the fathers may in unexpected and genetic ways be visited for untold generations on our progeny. As an optimist, I am hopeful that even though our generation fails to maintain the peace, some future generation will succeed. Let us endow this generation with the knowledge of our folly, and inevitably some of our debts, but let us leave it free to procreate at a handicap no greater than the natural spontaneous mutation rate.

It is a measure of the pace of recent events that this book, published less than a year ago, might be somewhat differently phrased if it were written today. To the statement of "... the flourishing state of science in the Soviet Union" (p. 132) might be added "except for the science of genetics." This is no superficial change. One wonders if the agreement among the nations on the control of atomic fission would not come to pass, or be speeded up, if the leaders of the Soviet Union were a little more convinced of the reality of the findings of genetic science. The development of the H bomb would possibly have modified the author's equation of the dangers of BW and atomic warfare. Then certainly there would have been considered a discussion of the meaning of the Soviet Union's recent unilateral moves to make propaganda capital out of Japanese BW efforts.

CARL LAMANNA

PINK PILLS FOR PALE PEOPLE.

By F. William Saul. Dorrance & Company, Philadelphia. $2.50. 204 pp.; ill. 1949.

Some years ago a reviewer in these columns pointed out what a valuable contribution to folk lore a history of quack medicine would be. It would also be quite exciting reading. The work here under discussion is no history of quackery, but it is so surcharged with historical material that no one who is eventually to undertake such a work can afford to overlook it. The author makes it quite clear that there are two types of quack medicine. First, there is that large body of superstitious belief which has slowly accrued through the centuries and which has invested with specific medicinal powers almost every object which can conceivably be ingested. This type of quackery is interesting because it has not been perpetrated as a deliberate fraud—there is no pecuniary advantage to be gained

by the propagation of the belief that cabbage is a specific for cancer of the breast, or that wax from the ears is good against whitlows, whatever those may be. The reviewer recalls the suggestion made by an elderly female relative when he was suffering from typhoid fever, that he should bind to the sole of each foot half of a freshly killed pigeon. No, this body of belief is the product of honest but ignorant persons who have imagined themselves cured of various diseases (which they may never have had) by the application of these bizarre medications, and perhaps some of the claims on behalf of them are not without foundation. For instance, it seems quite reasonable that an infusion of toe-nails taken internally might be an efficient emetic, especially if the patient is aware of what is being administered.

A few centuries ago this sort of quackery was indistinguishable from orthodox medicine. The works of Galen are a peculiar mixture of legitimate medicine and quackery, and the Badianus Manuscript, a legitimate medical work, reads strangely like *The Long Lost Friend*, which is probably the most famous compendium of quackery in history and even today circulates widely in the more backward areas of the nation. Strangely enough, the author has completely ignored this classic, though he might have derived much aid and comfort from it.

The other type of quack medicine is that resorted to by unscrupulous exploiters of the inborn desire of *Homo sapiens* to take medicine, a desire which, according to Osler, is the most important difference between man and the other animals. Among these quacks the author mentions by name Elisha Perkins, S. R. Chamley, Gerald Macaura, and many others whose names are now forgotten and who profited from the gullibility of those who have contracted the sort of diseases not commonly talked about in public, or who have exposed themselves to infection yet are not sure that they are infected. This type of quackery is ancient. The author is able to quote an historical record from the fourth pre-Christian century.

On the cover of this volume are facsimiles of the advertising of Lydia E. Pinkham's Vegetable Compound, Piso's Cure for Consumption, and various other "cures" for goiter, obesity, failing eyesight, and constipation. These advertisements bring back vivid memories of the days when song books and almanacs published by Ayer, or by Hostetter, could be obtained free every January from the country drugstore. On the title page of each almanac was the figure of a man whose anatomical structures were in some mysterious way correlated with the signs of the zodiac, and whose lower abdomen had been surgically operated on to reveal certain structures that would not otherwise have been in evidence. It so happened that in those days a certain popular manufacturer of boys' clothing designed a pair of trousers that unbuttoned in the same pattern as that of the abdomen of the man in the almanac, and just as children of today adopt the speech of Amos and Andy and the mannerisms of Howdy Doody and Popeye the Sailor Man, just so did those of an earlier generation go around with their pants unbuttoned to resemble the figure in the almanac. Fortunately the reviewer was never caught at it.

The author supplies ample proof that other things besides medicine are subject to quackery. For instance, he quotes many literary effusions of a pseudo-poetical nature, all of which are bad and most of which are terrible. These could very appropriately be called quack poetry. Similarly the numerous drawings incorporated in the book illustrate what might well be designated as quack humor. And finally, even quackery itself may be quacked. The numerous details which the author gives us to show how the art of dentistry and other surgical arts have been practiced in the past are quite authentic. Such practices cannot be considered genuine quackery; they are only quack quackery.

JOSHUA L. BAILY, JR.

HOSPITAL TRENDS AND DEVELOPMENTS, 1940–1946. *Edited by Arthur C. Bachmeyer and Gerhard Hartman. The Commonwealth Fund, New York; Geoffrey Cumberlege, Oxford University Press, London.* $5.50. xiv + 819 pp.; ill. 1948.

The increasing complexity of the hospital's organization and the broadening scope of its functions make it practically impossible for the busy administrator to keep abreast of the literature pertaining to his field, particularly when it is realized that articles of interest to him appear in a wide variety of journals relating to hospital care, medicine, public health, business organization and management, law, sociology, psychology, and many additional related fields. Thus, in order to provide the hospital administrator, or the student of hospital administration with a fairly complete and accessible reference to the pertinent literature on the subject, the editors have combed a wide variety of journals, and have selected and reprinted here some 150 papers covering the most important aspects of hospital trends and developments for the period 1940–1946. The papers have been edited only very modestly, resulting in minor losses of certain illustrative materials where considerations of space made it necessary. The papers have been arranged in chapters relating to such specific topics as Hospital Service, Medical Staff Organization and Relationships, Hospital Organization and Management, Outpatient Department, Nursing Education and Nursing Service, Medical Social Service, Medical Records, Hospital Construction, Food Service, Public Relations, and Group Hospital and Health Insurance. In addition to such bibliographic footnotes as are included in the individual papers, the editors have listed at the end of each chapter a series

of references for further reading on the topic under consideration.

Although there is no index of subjects or authors, the detailed table of contents serves adequately for reference to the volume. The work will undoubtedly prove itself to be as valuable as its companion piece, *The Hospital in Modern Society*, which appeared in 1943.

B. AUBREY SCHNEIDER

MEDICINE FOR MODERNS. *The New Science of Psychosomatic Medicine.*

By Frank G. Slaughter. Julian Messner, New York. $3.50. x + 246 pp. 1947.

This is no textbook in psychosomatic medicine but a rather successful "attempt to present to the lay reader in nontechnical language a survey of this, the newest, most fascinating field of medical science." The author's point of view has developed through many years of surgical practice and was strongly influenced initially by Adolf Meyer, whose student Slaughter was, and later especially by the work of Franz Alexander and H. Flanders Dunbar.

Slaughter covers an extensive range of psychosomatic topics beguilingly headed: Medicine For Moderns; Understanding Your Autonomics; The Anatomy Of Fear; Forming The Personality; The Case Of The Blushing Stomach; The Discontented Colon; Doctor—My Heart!; Hostility And Hypertension; Harnessing The Blood Stream; Coronary Thrombosis—The Price Of Success; Diabetes And Dementia Praecox; Asthma—Allergy And Emotion; Some Call It Migraine; My Love Is Rosy Red; Emotions And The Endocrines; Fibrositis—The Fashionable Backache; Woman! The Enigma Explained; The Reluctant Lover; Accidents Don't Happen By Accident; Psychometry—Testing For Type; Psychotherapy—Treating Diseased Emotions; Newer Methods Of Treatment; Is This Operation Necessary?; Destiny and Disease; Revolution In Medicine; For Parents Only.

The author's style is in keeping with the appeal of chapter headings and is enlivened with an abundance of case histories neatly focused for telling effect. Nevertheless, readability has been achieved at the expense neither of authenticity nor accuracy. The evidence which the author brings to the reader is cogent and convincing. Psychological medicine cannot—but further should not—be the exclusive province of the psychiatrist. Slaughter's case against "medicine" which considers only the disease and not the patient is in itself a positive contribution to the layman's medical thinking. This book will certainly contribute to a more widespread and a more informed popular understanding and appreciation of the dynamic interrelations between physical health and psychological well-being.

JOSEPH C. FRANKLIN

PSYCHOSOMATIC MEDICINE. *The Clinical Application of Psychopathology To General Medical Problems. Second Edition.*

By Edward Weiss and O. Spurgeon English. W. B. Saunders Company, Philadelphia and London. $9.50. xxx + 803 pp.; ill. 1949.

This edition is essentially the same as the first, except for minor changes in arrangement and the incorporation of some new material, particularly a chapter on psychosomatic diagnosis. The first edition has been reviewed by one who is apparently friendly disposed to the general subject and ideas covered in this text. (Q. R. B., 19: 72. 1944). Since the present reviewer is not so inclined, potential customers are referred to that earlier review.

It is clearly evident, even to the casual reader of the history of medicine, that the faith in the psychic origin of disease is too deep rooted to be easily changed. Few will deny the fact that psychological factors are of importance *in the management* of the sick, for it is well known that such factors affect the behavior and capacities of individuals during the course of any illness. It also is reasonable to assume that in cases where there is a predisposition to certain organic lesions, permanent structural alterations or functional impairment may be precipitated by an emotional crisis. This last is to be qualified by defining "predisposition" as an actual, though in some instances, not easily detectable, physical defect. However, a critical examination of the results of studies to date do not justify the conclusion that psychological or psychopathological factors are of direct importance in the etiology of somatic disabilities. The available evidence offered in support of the formula that "psychological disturbance → functional impairment → cellular disease → structural alteration" is anything but convincing.

To be sure, the authors of this treatise repeatedly make statements that appear to indicate a qualified acceptance of the above formula. For instance, in their introduction we read: "It seems probable that future investigations will permit us to say that it is possible for a psychological disturbance to antedate the functional alteration," (pp. 4–5) and in evaluating the emotional factor in the etiology of organic heart disease, they emphasize: "*The mere discovery of unpleasant circumstances in the life situation of an individual is no indication of emotional complications and still less of the psychogenic origin of the difficulty.*" (p. 275). This is a very reasonable observation. And, again we read, in their discussion of the possible role of psychogenic factors in causing essential hypertension: "*Please do not understand, however, that we are maintaining that psychological factors are the only ones of importance in hypertension or even that they are fundamentally responsible.* What we are urging, rather, is that they are a set of factors that are important to the patient with hypertension and that their modification often results in benefit to the patient regardless of whether the blood

pressure figures are lowered or not." (p. 341). This is not considered unsound medical practice, for apparently very few find fault with therapeutic procedures that, although not curing hypertension, at least leave the patient in a pleasant frame of mind.

In criticizing the suggestions of Trueta and his coworkers ("that the principal etiological factors responsible for hypertension will be found in the central nervous system even in the human mind itself"), Weiss and English write: "We doubt that a complete understanding of essential hypertension lies within the province of psychological medicine . . . " (p. 305). However, they continue in the same sentence " . . . but we share with the authors of this remarkable work the enthusiasm for a unique approach . . . "

There are many more such sentences, all of which if taken at face value would indicate a reserved or qualified acceptance of many of the doctrines adhered to by the psychosomatic enthusiasts of today. But, standing in contradiction to these statements there are just as many that support such doctrines. For example, in the section dealing with the psyche and hypertension, and directly after their criticism of Trueta's theories given above, they state: "Therefore, it may be said that in spite of the organic nature of experimental hypertension, the psyche is not absolved as a factor in the etiology of hypertension in man. It is conceivable that a disturbance in the circulatory function of the kidneys could have its origin in impulses of central nervous origin." (p. 305). The subject discussed in this section and in the sentences immediately preceding this statement leave little doubt but that by "central nervous origin" they mean psychological factors.

Finally, their discussion of the etiology of peptic ulcer is most revealing. Starting with the statement that "The term psychosomatic can be used without hesitation in connection with peptic ulcer because today even the most organically minded physician recognizes the importance of 'emotional factors' in ulcer cases" (p. 433)—they develop the theme with the words: " . . . We are confronted with imposing evidence that psychic factors are of the greatest importance as a cause of peptic ulcer . . . " There are other examples of such about faces, but the foregoing will serve for the purpose of this review.

Now, what makes up the "imposing evidence" that supports the premise that psychic or personality factors are of "greatest importance" in the etiology of peptic ulcer or, for that matter, any other organic disease or permanent structural alteration? It appears that the available evidence offered in support of such views is obtained from the psychiatric examination of a few small groups of individuals suffering from certain organic dysfunctions. From these findings the authors of such studies usually conclude that a high correlation exists between psychological or psychopathological factors and the disease in question. In examining the results of such studies and considering the contention that there is a specific etiological relationship between psychic factors and permanent structural alterations, it is necessary to bear in mind that what has been only factually established is that among a small portion of individuals suffering from an organic disturbance some neurotic individuals can be found. A relevant but unanswered question is whether such neurotic trends are absent or occur less frequently in those who do not suffer from the disability. Also, there is no information offered as to the incidence of the disease under study among the distinctly neurotic members of the general population.

Another argument which has very often been advanced by psychosomatically inclined investigators is based on the well-known observations that certain normal psychic manifestations, such as fear and rage, are capable of producing transitory alterations in the functioning of certain autonomically supplied systems. A priori, it would seem reasonable to assume that if emotional factors are capable of producing a transitory elevation of blood pressure, surely they must be of importance in producing the permanent pathological condition. The weakness of this argument is that there is no sound evidence to show that such transitory responses to normal emotional disturbances, even when repeated quite frequently, will produce permanent changes or alterations in function of a healthy organ.

In ancient Babylonia there was a group of priestly doctors who occupied a high position in the state. They were primarily concerned with internal, mental, and nervous diseases, and it seems that a popular specialty among them was that of foretelling events by the appearance of the liver. For this reason, and because they believed that all the emotions, as well as the ills of the body, could be ascribed to that organ, they were known as "Hepatoscopists." The philosophy underlying the procedures of those ancient Chaldean priest doctors was probably inherited from the early Sumerians or possibly from a still more primitive group. Regardless of its ultimate origin, the idea has survived through the ages and can also be observed in practice today in the methods of the Siberian shaman and the African witch doctor, whose dogma, interestingly enough, is that "in all cases of disease in which no blood is showing the patient is suffering from something wrong in the mind." The general idea can also be found in the procedures of the Iroquois medicine man, who based much of his treatment on the principle that every illness is a "desire of the mind." It is tempting to suggest that present day practitioners of that ancient art be called "psychoscopists." This would differentiate them from those psychiatrists who confine their studies to diseased or ailing minds. In this new category, I am sure, a place might also be found for the psychoanalysts. I hasten to explain that the suggestion of this new terminology does not infer any close similarity between the procedures of the uncivilized Siberian shaman or Iroquois medicine man on

the one hand, and those of the highly cultured and expensively educated modern practitioners of the ancient art on the other, for it is well known that the shaman uses a drum and the Indian medicine man a magic rattle.

DAVID B. TYLER

HEART. *A Physiological and Clinical Study of Cardio-Vascular Diseases.*

By Aldo A. Luisada; with a foreword by Herrman L. Blumgart. The Williams & Wilkins Company, Baltimore. $10.00. xii + 654 pp. + 1 chart; text ill. 1948.

Several of the best known textbooks on cardiology (*Diseases of the Heart* by Sir Thomas Lewis and *Clinical Heart Disease* by Samuel A. Levine) are notable for the personal biases and interests of the authors. Luisada's new book is an even more personal presentation. He brings to bear on the subject not only his many years of work on graphic registration, pharmacology, cardiac drugs, and numerous studies of pathological mechanisms, but also much European thought not otherwise readily available in this country. This makes the reading of the book something of an adventure.

The introductory section includes chapters on development and structure, on physiology, and on technical study of the cardiovascular system. The anatomy is classical and is presented with a rather heavy hand. Controversial material, such as the work of Glomset who decries the presently accepted anatomy of the conduction system, is avoided. The chapter on physiology embraces many unusual concepts, the most noteworthy being the origin of the dichrotic wave of the pulse in the active contraction of the peripheral arteries in response to systolic distention. A large portion of the technical study is devoted to phonocardiography and other rather unfamiliar graphic registration techniques. Electrocardiography is described in a rather perfunctory fashion with, for example, only mention in a footnote of the valuable unipolar limb leads. The choice of material in this section at once recommends the book very highly to a small number of persons interested in the pulse wave and similar phenomena and confuses the average reader. The mention of many of the newer techniques, including electrokymography and cardiac catheterization will, however, interest many. Unfortunately, the extensive chapter bibliographies are without titles and are not arranged by subject, hence are useful only in close conjunction with the text.

The bulk of *Heart* is clinical and covers examination of the patient, modes of origin of cardiovascular disease, pathological mechanisms such as those of cardiac failure and pulmonary edema, and an anatomical arrangement of disease states. Material is presented with relatively little discussion and a notable tendency to dogmatism. The text is clear and straightforward, with well chosen illustrations, and should appeal to practitioners. It contains, in addition, enough unusual material and strongly voiced personal ideas to be both enjoyable and stimulating.

E. CONVERSE PEIRCE, 2ND

LECTURES ON THE LIVER AND ITS DISEASES. *Comprising the Lowell Lectures Delivered at Boston, Massachusetts, in March 1947.*

By H. P. Himsworth. Harvard University Press, Cambridge. $5.00. xiv + 204 pp. + 1 plate; text ill. 1948.

Diseases of the liver are a challenge to the clinician since that organ possesses such a reserve of function that damage is usually far along before clinical signs of impairment become evident. Furthermore, the relation of deranged function of the liver to a particular lesion is difficult, as similar symptoms may result either from gross alterations in structure or from lesions so subtle that they do not produce any apparent structural alterations. Nevertheless, if the initial lesion can be recognized, therapeutic measures may be instituted at early stages with better chances of obtaining effective results. In this monograph, based on a series of lectures delivered at the Lowell Institute in 1947, Himsworth has arranged his subject matter in groups and sequences so as to correspond fairly definitely to the pathological sequences observed both in man and experimental animals. By so relating one pathological form with another, the possibility of recognizing the initial lesion of each category is enhanced.

In grouping and cataloguing the available knowledge of liver diseases, Himsworth has revealed the large gaps in our knowledge. The book is divided into 12 chapters and covers the following principal subjects: The Types of Liver Injury and their Structural Consequences; The Vascular Factor in Liver Injury; Nutritional Factors in Liver Injury: Experimental; Nutritional Factors in Liver Injury: Human; Noxious Factors Causing Liver Injury; The Syndromes of Hepatic Failure; The Clinical Classification of Liver Disease; Infiltrations of the Liver and Post-Infiltrative Fibrosis; Parenchymatous Hepatitis; Cholangio-Hepatitis, Obstruction to the Bile Ducts, and Biliary Diffuse Hepatic Fibrosis; Circulatory Disorders; Focal Lesions; and Cancer of the Liver. This authoritative book is well written and undoubtedly will stimulate further experimental studies on problems of great clinical and physiological interest.

DAVID B. TYLER

PUBLIC HEALTH AND HYGIENE: *A Students' Manual. Fourth Edition.*

By Charles Frederick Bolduan and Nils William Bolduan. W. B. Saunders Company, Philadelphia and London. $4.25. x + 423 pp.; ill. 1949.

The fourth edition of this standard textbook follows much the same pattern of organization and presentation as the earlier editions, with such necessary revisions and additions as were necessary to cover recent scientific advances, particularly in the fields of antibiotics, insecticides, herbicides, and radioactivity.

The text is divided into five parts, dealing respectively with: (1) general considerations of public health; (2) the more important communicable diseases; (3) the more important non-communicable and chronic diseases and conditions; (4) community hygiene; and (5) public health administration. Among the general principles of public health considered in Part I are such topics as the historical development of the public health movement, the transmission of communicable diseases, the life histories of certain insects directly related to health problems, the principles of nutrition in health and disease, and the socio-economic factors in public health. The section on communicable diseases is concerned with the causative organisms, the modes of infection and spread, as well as control measures relative to many conditions including tuberculosis, pneumonia, influenza, diphtheria, scarlet fever, typhoid, typhus, malaria, yellow fever, dysentery, and the venereal diseases. Such non-communicable and chronic diseases as diabetes, heart disease, and cancer are discussed in relation to our aging population in Section III. Sections IV and V present a description of the administrative set-up for public health activities on federal, state, and local levels, and some of the basic problems which are dealt with by such facilities, e. g., sewage disposal, water and food supply and inspection, industrial hygiene, school health, public health nursing, and health education. The volume is well adapted for a senior high school or junior college course in hygiene. It is well illustrated and documented, and carries indices of subjects and authors.

B. Aubrey Schneider

Language and Language Disturbances. *Aphasic Symptom Complexes and Their Significance for Medicine and Theory of Language.*

By Kurt Goldstein. Grune & Stratton, New York. $8.75. xii + 374 pp.; ill. 1948.

Over a period of almost 45 years, Goldstein has thought and written much about various aspects of the diagnosis and treatment of aphasia. This book represents a synthesis of his work and his ideas. Goldstein's expressed purpose is twofold: (1) to develop a theory of language disturbances that is broad enough to account in detail for known symptom-complexes; and (2) to outline diagnostic and therapeutic procedures that are consonant with this theory and useful in prognosis and retraining.

Part I is concerned with a study of the origin of aphasic conditons. Four categories are adduced: (1) symptoms representing defects of performance (Jackson's "negative symptoms"), which Goldstein calls *direct*; (2) symptoms caused by the separation of an undamaged area from a damaged area (Jackson's "positive symptoms"), which Goldstein calls *indirect*; (3) symptoms which are effects of the damaged area upon the rest of the nervous system, called *secondary*; and (4) symptoms which reflect the operation of mechanisms to protect the personality from catastrophe. Within the framework of these categories, Goldstein postulates an "organismic approach to aphasia," that is, "the trend of the organism to actualize itself, its 'nature,' its capacities, as well as possible." Accordingly, "it follows that every individual speech-performance is understandable only from the aspect of its relation to the function of the total organism in its endeavor to realize itself as much as possible in the given situation." Herewith, the nature and extent of the indirect, the secondary, and the protective symptoms carry importance in detailed diagnosis and, more particularly, in spontaneous restitution and in retraining. Goldstein outlines the essential differentiation between the organismic and the more classical approach (labeled "atomistic"), which is keyed to anatomic-physiologic concepts of integrated cortical centers, in a tightly argued discussion of verbal imagery, the differences between concrete and abstract language, and the localization of language and language disturbances. His arguments are supported by analyses from the fields of semantics, psychology, and linguistics. His findings are specified in a survey of a wide variety of language disturbances in pathology.

Part II presents a series of detailed case-reports (including diagnostic tests and their interpretations), analyses of expressive, receptive, central, amnesic, and transcortical aphasias, and a brief section on treatment. In general, Goldstein's nomenclature is conservative and eclectic, and is designed to emphasize the need for comparison and correlation among symptom-complexes.

This is a difficult book, but a stimulating one, provocative of thought and argument in a field wherein much has been written, wherein theory is widely divergent, wherein clinical practice is often sketchy, and wherein much detail is as yet undemonstrated and undemonstrable. Goldstein is well aware of many of the shortcomings of an attempt to bring about a marriage between the empiric and the theoretic in the field of language disturbances. He writes with forbearance from a wealth of clinical experience and creative construction, and with a focus on the premise that the brain both affects and is affected by its substrata, in whole and in part. The study of language in all

its aspects is a tremendous activity in these days, and to this study Goldstein has made a real contribution.

WILLIAM G. HARDY

TWENTIETH CENTURY SPEECH AND VOICE CORRECTION. *Edited by Emil Froeschels. Philosophical Library, New York.* $6.00. x + 321 pp.; ill. 1948.

The declared purpose of this book is to present "to persons scientifically and/or practically interested in speech and voice correction the latest developments in this field." Both design and execution fall short of that goal. Together with his own various and extensive contributions, the editor has called upon 18 colleagues to express themselves. This they have done within no clear framework, and with a startling and frequently disconcerting array of styles and perspectives. The essayists follow their individual bents through the intricacies of theoretical construction, diagnostic practice, and therapeutic procedures related to language disorders, auditory disorders, and a smattering of vocal training and reading disability. Some undertake to teach, others to outline clinical procedures, others to analyze theory and practice by case-presentation, and still others to argue the merits of particular attitudes and practices. The general effect is a spottiness that is not redeemed by some excellent essays. There is no orderly progression through a complex field that is itself a synthesis of several clinical and research fields. Because of the variety of subject matter and points of view, this book should prove most useful to the specialist who already knows his way in speech correction; for the newcomer or the casual inquirer, it provides neither analysis nor synthesis and would be quite misleading as a picture of speech and voice correction today.

WILLIAM G. HARDY

PSYCHOLOGY AND ANIMAL BEHAVIOR

MY MONKEY FRIENDS. *Second Edition. By Mrs. Charles E. B. Russell. Adam & Charles Black, London.* 7s. 6d. 127 plates + 19 plates. 1948.

The author of this small, popular book was for several years a volunteer helper at Albert Schweitzer's hospital in Equatorial Africa and has traveled extensively in many parts of the world. She writes entertainingly of her trips, and especially about the many infant monkeys and apes which she has at times adopted with tender care and which often accompanied her in her traveling. Judging from the 31 small photographs, these pets have included gorillas, chimpanzees, several species of guenons, and a mandrill. From these pages it is very evident that companionship, plenty of exercise, and, of course, a suitable diet are essential for the welfare of these social and active animals and that given such conditions all these primates form fond and trusting attachments to a sympathetic human master—at least while they are young. The last chapter, On Keeping Monkeys, is written on the basis of long experience and its sound advice will profit all owners of simian pets.

A. H. SCHULTZ

EXPERIMENTAL STUDIES IN PSYCHODYNAMICS. *A Laboratory Manual. By Donald W. MacKinnon and Mary Henle. Harvard University Press, Cambridge; Geoffrey Cumberlege, Oxford University Press, London.* $5.00 (paper). x + 177 pp. 1948.

In this manual, MacKinnon and Henle have undertaken something that was very badly needed and extremely difficult to do. They have tried to bring down to the level of the classroom the pioneer attempts to investigate problems of personality and motivation by means of experimental techniques. The success of the book is due to the experience and ingenuity of the authors. Its weaknesses are the result of our inadequate knowledge of the field that they attempt to explore.

The manual deals for the most part with experiments designed originally by Lewin and his associates. Most of these experiments are classical, in the sense that they led to new information and to new areas of investigation and are now known as mileposts in the development of personality theory. Still, these experiments are so enmeshed in clinical techniques that it is difficult to be sure where experimental control begins and where the art of the clinician ends. A few examples will suffice.

In the prefatory instructions to the student the authors have written the following: "Acting as experimenter in these studies consists in large measure of playing a role. Before coming to the laboratory it is important that the student study his part so that in the actual experiment he can play it with ease and confidence."

On one occasion the authors have written: "The experimenter begins by friendly conversation with the subject, in order to establish rapport with him. It is important that good rapport be established, since the experimenter must obtain maximum cooperation from the subject. But it is equally important that the distance between the experimenter and the subject be maintained. Since the subject is to be led to believe that his intelligence is being tested, the experimenter must maintain the serious attitude of an examiner throughout the experiment." Again: "By means of

preliminary friendly conversation with the subject, the experimenter creates a free and unrestrained experimental situation."

The instructions in experiment after experiment are of this order. In many cases there is almost no assistance given by the authors to the potential experimenter in exact techniques for accomplishing what he is told to accomplish in the way of establishing a social situation. This is a very serious weakness in the method of presentation. Without modification in this regard by the instructor who uses the manual, it is hard to see how these experiments could serve a very good pedagogical purpose. On the other hand, if we assume that such modifications are made, this should be a very useful book. In any case, the authors are to be congratulated for having broken ground in this new area.

WILLIAM C. H. PRENTICE

THE PSYCHOLOGY OF TEACHING. *Second Edition.*

By Asahel D. Woodruff. Longmans, Green & Company, New York, London and Toronto. $3.00. xiv + 272 pp.; ill. 1948.

This is a book in educational psychology, which makes it immediately suspect to many psychologists and to many educators. As the author himself points out, much of what is called educational psychology can be criticized as being too far removed from the actual problems of day-to-day teaching. In many instances college courses labeled "educational psychology" are only imperceptibly different from courses in general psychology—and instances can be reported in which an instructor meets both classes in the same room at the same hour, using a single text and a single set of lecture notes. On the other hand, the experimental or the clinical psychologist may ask what material has been uncovered or synthesized that justifies this special category. Is it psychology or is it pap?

It can certainly be argued that a teacher's ability to guide the development of his pupils can be the better for having absorbed the material presented in psychology courses of the non-educational brand. Many are able to deepen their insight into personality dynamics (their own as well as their pupils') through courses in clinical psychology. The intelligent use of evaluative devices will be most difficult without a solid foundation in the theory and practice of testing and in the area of individual differences. The experimental literature in the field of learning can be a sound starting point for the growth of a teacher's own practical skills in the classroom, and some knowledge of the physiological and developmental aspects of emotional behavior should be a helpful adjunct in understanding the whole pupil. Perhaps even some information concerning receptor and perceptual processes could be of value to the teacher in elementary and secondary schools. All this would require an undergraduate major, or even an advanced degree, in psychology, leaving courses in "professional education" to fill in a few miscellaneous chinks and odd hours. Perhaps boards of education, however, to say nothing of professional educators and education students themselves, might feel this to be as inadequate a training for teaching as would be just the preclinical program for physicians. Hence the effort, illustrated in this book, to extract just those items of psychology that may be clearly pertinent to the classroom, and to show how they may be applied by the skillful teacher.

The only trouble is that, when so extracted, many of the items appear to the non-educational psychologist to be so far removed from clinical and experimental psychology as to be non-psychology! Not that what is said necessarily controverts the findings of the laboratory or the clinic. Rather, so much of it could have been said by any alert schoolman with a minimum of strictly psychological training. And as soon as the statements are presented without the imperative specifications and qualifications of the scientific setting, there is danger that they become either misleadingly simple or meaninglessly ambiguous. It is difficult to defend, disprove, or even to apply objectively such a proposition as "It is psychologically sound to assume that each student will do his work unless there is something wrong with him that needs attention" (p. 178).

The critical question is: Will this book be of value in education classes? It could be. The general outline, the logic of organization, the realistic projects presented with several chapters, all suggest that the author, in his own educational psychology classes, develops the themes in a way to gratify both the educator and the psychologist. But an instructor with a less complete background and a limited imagination will be unable to clothe with operational meaning the well-sounding words. In short, placed in less certain hands, this will be merely "another educational psychology textbook."

FRANK W. FINGER

YOUR CHILD'S MIND AND BODY. *A Practical Guide for Parents.*

By Flanders Dunbar. Random House, New York. $2.95. xii + 324 pp. 1949.

Flanders Dunbar has written another comprehensive book relating psyche and soma. This time she energetically attacks the problem from the pediatric level. She has an enviable background as physician, mother, and pioneer in psychosomatic medicine upon which to draw for such a survey. With fine assurance she has produced a good book for parents to read—full of constructive illustrations, matter-of-fact descriptions, and definite directives.

The book is actually written *to* parents. Chapter headings are questions penetrating anxiety-laden areas for those who are bringing up children: Does Your

Child Sleep?; Does Your Child Eat?; Does Your Child Play?; Do You Love Your Child?; Does Your Child Obey?; Does Your Child's Body Obey Him?; Does Your Child Get Sick?; Does Your Child Commit Minor or Major Crimes? These broad questions just about cover everything, at least in the way the author treats them. After developing the theme of each chapter in terms of the youngster of pre-school or grammar school age, Dr. Dunbar appends a few words on "the Adolescent Aftermath" as a follow-up on a much neglected period of development. This is a very original and useful addition, greatly enhancing the value of the book as an aid to thoughtful parents whose children *do* grow out of childhood into adolescence, with all that period's special complications. *Your Child's Mind and Body* is written in a vivid, authoritative style. There can be no doubt that Flanders Dunbar knows her own mind and is convinced that she has ideas of real value for her audience. She does, too!

HELEN ARTHUR

YOUR CHILD MAKES SENSE. *A Guidebook for Parents. By Edith Buxbaum; foreword by Anna Freud. International Universities Press, New York.* $3.25. xvi + 204 pp. 1949.

This is an excellent book on the psychology of childhood, from the dynamic orientation of psychoanalysis. Edith Buxbaum had her original training in Vienna with Anna Freud and has since had many years of child psychoanalysis. This makes her unusually well-qualified to write on a topic which has been subjected to so much undisciplined verbosity. Following an impressive foreword contributed by Anna Freud and a friendly introductory page or two by the author is chapter 1, contributed by Florence L. Swanson, on the Physical Development and Care of the Child. This sets the stage for the correlation that must be felt between the physical and psychic aspects of the growing individual.

From this point on Edith Buxbaum takes over, covering a number of important issues that parents should know about in order to be more successful parents. She discusses among other things the mother-child relationship, sex development, the child and his family, and the child and his school. These are, of course, the usual items, but in this volume they are treated in a new way, a much more valid and pragmatic way, from the point of view of what actually goes on in the child's emotional life. At the end there is a section entitled Related Reading to which an interested reader may turn for a recommended bibliography on child care and emotional development. This list alone makes the volume an important contribution to literature of this type.

Your Child Makes Sense is written specifically for non-professionals. The author spends no time on theory alone. She briefly states the psychiatric facts involved but relates them immediately to actual situations. She has an effortless, somewhat amorphous style that carries the reader along easily but not soporifically. Because of its non-technical approach, this book can be read by anyone. Because of its sound psychodynamic orientation to the common childhood problems, it should be read by all who question their child's behavior. This does not exclude psychiatrist parents, who are often in need of just such a down-to-earth, practical presentation of certain everyday issues.

HELEN ARTHUR

THE PSYCHOANALYTIC READER. *An Anthology of Essential Papers with Critical Introductions. Edited by Robert Fliess. International Universities Press, New York.* $7.50. 392 pp. + 1 chart. 1948.

This is a book of genuine importance to all students of psychoanalysis. Fliess has done a real service in compiling in one volume 27 important psychoanalytic papers, hitherto either very difficult to find or not even translated. He has devoted an immense amount of time, as well as professional discernment, to going through the psychoanalytic literature, sorting out repetitious, non-contributive papers, and finally selecting the basic articles included here.

In this book, the first of a contemplated series, Fliess has grouped the papers under five topic headings: Clinical; Theory; Miscellaneous; Uncollected Papers by Karl Abraham; and References by Freud. This last section is fascinating, for papers to which Freud has referred in his writing are quoted in full, along with the parts from Freud's own writings which contain the allusion. Because of the careful grouping of the papers, the exceptional quality of all of them, and the fact that all the authors are (or were at the time of writing) traditional Freudian psychoanalysts, the continuity and coherence of thought in the book is quite impressive. Not only the original authors, but also the editor, must be credited with excellent work. Future volumes will be awaited eagerly.

HELEN ARTHUR

THE NEUROSIS OF MAN. *An Introduction to a Science of Human Behaviour. By Trigant Burrow. Harcourt, Brace and Company, New York; Routledge and Kegan Paul, London.* $7.50. xxvi + 428 pp. + 5 plates; text ill. 1949.

The general thesis of this book is that man as a species is the victim of a neurosis, due to the fact that his "third nervous system," that making possible symbolic function as contrasted with the visceral and sensory-

motor functions of the other two, has tended to separate him from his environment and has thus induced a partial (partitive or ditentive) reactivity replacing the whole (cotentive) reactions which would otherwise take place. Out of this condition the author concludes that all the world's interrelational problems arise, and he posits that this "phylic" neurosis must be somehow cured before man can successfully escape the fate he appears to be making for himself with wars, atomic bombs, and the tendency toward strife in general.

It must be stated here that the above interpretation may well not be what the author intended to convey, since the book is written in a language the symbols of which are unusual and difficult in spite of their very frequent repetition. As a sample of the type of writing in which the ideas of this book are entombed, consider the following: "Accordingly, there is need to recognize that man's adaptation has come to be almost exclusively partitive, episodic, disjunctive. Dealing indiscriminately, as we now do, with the symbols or indices of objects and with the symbols or indices of one another, man has come to assume a projective basis of behavior that is wholly insular and discrete." (p. 169). It is unfair to pick a particular section—this is by no means the most exaggerated sample that could have been used—to characterize the language of a book. Nevertheless, the prospective reader should be warned.

The book pretends to be a report of experimental work and has an appendix giving some data on respiration, heart rate, basal metabolic rate, and oculomotor function in the various states of attention discussed by the author. For the most part it is, however, a rather confusing array of ideas. These ideas have relations with some familiar theses. One will find hints of a "back to nature" philosophy, of the control of thought and feeling through use of physiological function in a way reminiscent of Yogi cults, and a long dissertation on the differences between the author's philosophy and Korzybski's semantics. There is also an attempt to get at the biological implications of religion, to destroy the concepts of right and wrong, and to replace them with a concept of biological success and failure. Finally, there is an effort to show that if man were again to combine his symbolic functions, which are basically physiological, with the other recognized physiological functions, then all would be well.

One of the basic contentions in the book is that individuality is unsound and that it is nothing more than "face," also called " 'I'-Persona." It is not unfair to point out that the author has face enough left after his study to explain how his name is pronounced and to tell a number of his personal experiences, neither of which additions contributes to his thesis. There are some stimulating ideas in the book, but the cost of sharing them with the author is very great.

PAUL V. LEMKAU

MODERN PRACTICE IN PSYCHOLOGICAL MEDICINE. *Edited by J. R. Rees. Paul B. Hoeber, Medical Book Department of Harper & Brothers, New York.* $10.00. xii + 488 pp. 1949.

This textbook of psychiatry, intended for students of medicine and general practitioners, and written by a group of well-known British specialists, is a conservative statement of present thought concerning personality development and its deviations and treatment. It is conservative in the sense that it rests essentially on clinical observation, with a minimum of theory, which in fact serves no particular purpose in the actual handling of cases. Considering the statement in the foreword that attributes to Freud's contributions the great present day interest in things psychiatric, there is remarkably little about Freudian theory and research in the body of the text and in the references listed at the end of each chapter. There is no occasion to deny that this is a dynamic approach. It is such, but more in the traditional English sense, which follows the Meyerian tradition in this country. The several chapters dealing with personality development and the various forms of psychiatric deviation and treatment are very well presented, and this should be a good book for medical students and practitioners.

Only two contributions to the book come from America: one by D. Ewen Cameron, a Scot transplanted to this country, and one by Samuel W. Hamilton on the Medico-Legal Aspects of Psychiatry, as practiced in the United States. Cameron's chapter on Sexuality and the Sexual Disorders is factual, rests on common experience, and is remarkably devoid of esoteric theory.

WENDELL MUNCIE

PROGRESS IN NEUROLOGY AND PSYCHIATRY. *An Annual Review. Volume IV. Edited by E. A. Spiegel. Grune & Stratton, New York.* $10.00. xiv + 592 pp. 1949.

This excellent review of the most recent contributions in neurology and psychiatry has been ably presented by an imposing group of contributors and edited by E. A. Spiegel of Temple University. It is divided into four parts: The Basic Sciences, Neurology, Neurosurgery, and Psychiatry. Of the 582 pages of text, 178 are devoted to psychiatry. Nevertheless, throughout the neurological contributions one sees constantly the encroachment of psychological aspects as, for instance, in the chapters on the psychopathology of vision, the surgical treatment of pain and motor disorders, psychosurgery and the autonomic nervous system, and others. The psychiatric chapters are very well done indeed. These deal with clinical psychiatry, mental hygiene, forensic psychiatry, child psychiatry, neuroses, psychosomatic medicine, alcoholism, the Rorschach and other projective technics, shock therapy, group psychother-

apy, psychiatric nursing and occupational therapy, psychoanalysis, rehabilitation and reeducation. The material is well digested and amply documented. Assuming that the part dealing with neurology is equally well done, this book should be a very valuable addition to the medical library and a time-saver in combing the literature for pertinent material.

WENDELL MUNCIE

COMPULSION AND DOUBT. (*Zwang und Zweifel*). *Volumes I and II.*

By Wilhelm Stekel; authorized translation by Emil A. Gutheil. Liveright Publishing Corporation, New York. $7.50 for two volumes. (I) x + Pp. 1–323; (II) ix + Pp. 324–645. 1949.

In this two volume series, Stekel provides a very comprehensive treatment of the effects of anxiety, dread, and doubt upon human personality. He discusses in detail various forms of neurotic obsessions and compulsions, and attempts to demonstrate the hidden causes and subconscious motives involved in their development. The work is enlivened by the inclusion of approximately 80 case histories, many of which are presented in great detail. These case histories illustrate the effects upon personality and character of persistent compulsions and doubts. Typical chapters are devoted to criminal impulses, compulsions and masturbation, the incest complex, compulsion and impotence, homosexuality and patricide, and so on.

The over-all value of this work is difficult to estimate. It is apparent that Stekel is a disciple of Freud. Undoubtedly his interpretations of the case histories presented will appeal to all other analysts and psychiatrists who believe in the Freudian interpretation of personality. They will hail this new translation as a major contribution to the literature of psychoanalysis. Others, who deal with disordered personalities without benefit of Freudian doctrine, will be much less enthusiastic about the approach to the phenomena of compulsion and doubt taken in this book.

The present reviewer feels that the prevalence of anxiety, dread, doubt, compulsions, and obsessions among modern men makes it imperative that every clinician working in the field of personality disorders learn as much as he can about these phenomena. For this reason it is believed that these two volumes should be included in the professional library of every psychiatrist, psychoanalyst, and clinical psychologist. They would seem to have very little value elsewhere.

WENDELL W. CRUZE

BASIC PRINCIPLES OF PSYCHOANALYSIS.

By A. A. Brill; with an introduction by Philip R. Lehrman. Doubleday & Company, Garden City, New York. $3.45. xviii + 298 pp. 1949.

This is Brill's last writing, edited after his death by his friend, Philip R. Lehrman. As in everything Brill ever wrote, one finds here a commendable clarity and a singleness of purpose which leave the reader with admiration for the author's very real literary as well as scientific abilities. The book covers all the well known material of any psychoanalytic textbook, the history of the method, the basic tenets, and the basic manifestations in everyday life and dreams. There are very valuable chapters on the functions and motives of dreams and their interpretation, the types of dreams, and common forms of psychoses. Then there are some additional final chapters of general interest concerning the only child, fairy tales and artistic productions, and the selection of vocations.

There is nothing a reviewer can say to add to Brill's stature. It is fitting that the man who introduced psychoanalysis into this country should leave such a readable, instructive textbook on the subject.

WENDELL MUNCIE

SEXUAL BEHAVIOR: *Normal and Abnormal.*

By Eustace Chesser. Roy Publishers, New York. $3.75. xii + 295 pp. 1949.

The theme of this book is that sexual problems are usually personality problems, that personality adjustment is largely a function of the home in which the child has grown up, and that the most serious threat to this home is the mother's urge to be "emancipated." Chesser's first point is that the purely physical aspects of sex life have been overemphasized at the expense of the subtler emotional attitudinal aspects. Actually, they are inextricably interwoven, and tied in with the individual's whole pattern of habitual adjustment. Sexual deviations are much more often the result of emotional disturbances than their cause. Much of personality maladjustment can be traced to the long-standing cultural assumption (illustrated in the early Christian teachings) that woman is an inferior species and that sexual behavior is an unfortunate racial necessity. This leads to a certain amount of anxiety in nearly everyone, but in woman "the legacy of . . .confusion, resentment, fear, suspicion, and, above all, of shame" is so great that she quite understandably seizes the opportunities made possible by educational and economic changes to escape from the responsibilities of normal sexuality and maternity. This would not be particularly disastrous if some women rejected marriage altogether and the rest accepted it unconditionally. The critical problem centers around the large number who, unconsciously, reject the maternal role just enough to create in the home an air of discontent, uncertainty, and insecurity, which in turn distorts the whole personality (and hence the sex attitudes) of the next generation. Woman must be helped to understand that

she is not the inferior of the male—she is in reality superior, "Nature's chosen sex." And at the same time sexuality must be accepted by all in its proper perspective, as a natural drive that can reinforce the optimal development of the whole person.

The "abnormal" in the title is stressed very little in the discussion. For the most part extreme deviations are described only to illustrate the *quantitative* relation between the abnormal and that range of behavior that is classed as normal, and to reassure those who feel themselves to be greatly different *in kind* from the average of the population.

The rationale of the section on psychosexual development is unmistakably Freudian. The usual objections to the untestable hypotheses will of course be raised in this connection, although the descriptions are couched in such common-sense language as to be quite disarming. Beyond the dependence on psychoanalytic formulations, the book is clearly all Chesser's. The virtual absence of references to recent research on sex attitudes and behavior (Kinsey's name being conspicuously missing) leads one to wonder if the breadth of the author's acquaintance is as limited in his special field as it appears to be in some of the supporting areas. Perhaps it is just as well that such mechanical implements as statistics are eschewed, for in the one instance when he attempts to play with figures, Chesser falls into complete confusion. The lack of an index reinforces the impression that the book is intended to be read as an essay rather than studied as an authoritative textbook or used as a handbook. Regarded in this light, many of the ideas in *Sexual Behavior* are well worth consideration.

FRANK W. FINGER

HUMAN BIOLOGY

TRÆN-FUNNENE. *Instituttet for Sammenlignende Kulturforskning. Serie B: Skrifter. XLI.*

By Gutorm Gjessing, with the assistance of Ole T. Grønlie, Oluf Kolsrud, and K. E. Schreiner. H. Aschehoug & Company (W. Nygaard), Oslo; Kegan, Paul, Trench, Trubner & Company, London; Otto Harrassowitz, Leipzig; Société d'Édition "Les Belles Lettres," Paris; Harvard University Press, Cambridge. N. kr. 35.00 (cloth); n. kr. 30.00 (paper). viii + 234 pp. + 52 plates; text ill. 1943.

The archeological finds at Træna, a rocky island located on the Norwegian Coast just below the Arctic Circle, are interesting, rich, and variegated. On the island are found not only prehistoric caves, but also houses and graves. Here have been found a great many artifacts of bone, flint, and stone, as well as weapons, tools, and jewelry of iron, bronze, and gold. The accumulation of pottery is not insignificant. Last but not least, there has been found here a rather unusual material of human skeletons. With an intermission of a couple of centuries (the Merovingian times to the late Middle Ages), the finds cover a period of thousands of years, from the Older Stone Age (Paleolithic) to the Late Middle Ages.

The report on the bulk of the finds is written by Gutorm Gjessing. Exceptions are: a chapter on the geology of the island (*Kvartærgeologiska undersökningar*) by Ole T. Grønlie; a chapter on a golden ring found there (*Gullringen*) by Oluf Kolsrud; and a chapter on the skeletons (*Skjelletterne*) by K. E. Schreiner.

According to Schreiner, the racial characteristics of the skeletons do not differ much from what is known about medieval skeletons in Oslo. In general, the race seems to be Nordic, with some deviations (brachycephalism) pointing to the Alpine race rather than to the Lapps. Of the 47 individuals, 19 must have died before they reached the age of 20 and only 5 reached the advanced age of 50, one of whom may have become 60.

The ring is dated by Kolsrud to the first half of the 15th century on paleographic grounds. It has a magic inscription (*bure, berto, beriora*) to stop bleeding, to which there are several 15th century parallels in Scandinavia and elsewhere.

According to Gjessing the archeological material (skeletons, tools, pottery, etc.) was found both inside and outside the caves, of which *Kirkehelleren* (the Church Cave) was the most imposing, though not the largest.

Immediately south of that cave, in a bog, there were found ruins of old houses and a sort of a causeway of stones, leading over the bog to a place ca. 23 meters above the present sea-level. The archeologists decided that when this causeway was built, it led, indeed, down to the then existing sea-level (ca. 22 meters), and thus dated the path to the Older Stone Age (Paleolithic). Investigation of the ruins corroborated this: the artifacts, and probably also the house ruins themselves, date from Paleolithic times (more specifically from what the Scandinavian archeologists call Nöstvet-time). If so, these are the oldest known houses in Scandinavia, which makes the find important indeed. Of other results one may mention Gjessings' finding that the culture of the Stone Age remained much intact until the advent of the Iron Age.

There is no possibility of going into the rich detail of the book. It is a pity that the authors themselves did not give their results in short English résumés, for their finds seem to be quite important. Nevertheless, those who are really interested, geologists, archeologists, and anthropologists, can probably find their way around in the rich material of the Plates (52 in number) at the end of the book.

STEFÁN EINARSSON

PREHISTORIC POTTERY AND CIVILIZATION IN EGYPT. *The Bollingen Series VIII. Pantheon Books.*

By Max Raphael; translated by Norbert Guterman. Bollingen Foundation, Washington, D. C. $7.50. 160 pp. + 36 plates. 1947.

This strictly archeological treatment of the prehistoric pottery of Egypt resembles the author's previous contribution to this series, *Prehistoric Cave Paintings* (see Q.R.B. 21: 125. 1946), in elaborating the meaning of the ornamentation in terms of cults, in this instance the cult of the dead and the rites of magic. The style adopted by the author is simpler, however, and the interpretations are more direct and readily followed. The plates are outstanding.

BENTLEY GLASS

THE WOLF AND THE RAVEN.

By Viola E. Garfield and Linn A. Forrest. University of Washington Press, Seattle. $3.00. x + 151 pp.; ill. 1948.

The carving of totem poles is an art which was practiced very locally by the Indians of the Pacific Northwest, notably those of the Tlingit tribe. It is now largely a lost art, even though some of the poles were made as late as 1905. Modern philosophy, which came with the white race, has disrupted the nature culture with its strict adherence to maternal lineage, and the race myths and lineages which are symbolized in the elaborate carvings are remembered only by the older tribal members.

Recognizing that the wooden poles were in danger of extinction through decay, weathering, and pilfering, the U. S. Forest Service in 1938 began a systematic collection and restoration of totem poles, which were localized for the benefit of visitors and with the consent of the Tlingits. Parks at Saxman, Ketchikan, Mud Bight Village, and Klawak, in southeastern Alaska now contain the best of the remaining poles, through a project carried out by the junior author. Garfield, an anthropologist, has collected the legends, histories, and lineages which the poles symbolize. Each totem is discussed individually and each is illustrated by photographic reproductions. The total effort has resulted in a fascinating story of an Indian group which sought expression in a unique and spectacular manner. It is unfortunate that the half-tone illustrations do not provide the sharpness of detail and the color which the text deserves. When it is considered that the totem poles represent a form of art peculiar to a region of America and in its last stages of existence, one is led to wonder why nothing was done to preserve it before 1938.

C. P. SWANSON

CHINA: THE LAND AND THE PEOPLE. *Issued in Cooperation With The American Institute of Pacific Relations. By Gerald F. Winfield. William Sloane Associates, New York.* $5.00. x+ 437 pp. + 16 plates. 1948.

This is by far the best general account of China's problems now available. The author, a biologist of many years' experience in China in the field of public health, has not limited himself to an analysis of that aspect of China's needs, but has produced a remarkably well-integrated study of the interrelationships of the land's geographic and human characteristics, the agriculture, diet, clothing, and shelter of the people, their commerce, industry, and transportation, health, education, language, local government, and the far-reaching consequences of war.

It is the second part of the book, entitled Rebuilding China, that is most thought-provoking. A statement of needs and goals leads to a consideration, first of all, of sanitation, China's most gigantic health problem. "The annual toll of death from fecal-borne diseases is as high as four million—one-fourth the total number of deaths from all causes each year." Hookworms, flukes, and astronomical numbers of ascarids (from 5 per person in 35 per cent of the population in urban dwellers of the north, to 35 per person in 98 per cent of the population in the rural rice-growing areas) deplete the vitality and resistance of the people. But the prevalence of such fecal-borne diseases and parasites is the inevitable outcome of the dependence of the farming population on human excreta to replenish the nitrogen of their fields. ("It is interesting to note that the amount of nitrogen present in the feces cakes is in direct ratio to the richness of diet of the people producing the night soil.") No effort to eliminate these conditions can succeed until some cheap and effective way can be worked out to sterilize the human fecal materials before they are used on the fields or fed to the pigs. This can be done, as the author has shown experimentally at Cheeloo University in Shantung, by composting the excreta in mixtures of 20 per cent night soil, 50 per cent animal manure, 20 per cent vegetable wastes (such as wheat straw, leaves, or dry grass), and 10 per cent field soil. This sounds simple to do, but anyone who knows China will at once see the difficulty. The plant wastes are universally used by the farm populations as the principal supply of fuel, wood for such purposes being extremely scarce. Hence, to solve the sanitation problem in the way proven to be feasible will require first a new source of fuel for the Chinese people. A great dam across the Yangtze River in the gorges above Ichang *could* supply over 10,000,000 kilowatts (3 times the generating power of the Grand Coulee, Hoover, and Shasta dams combined) and has been planned; but even this supply of power would have to be supplemented by a vast increase in the amount of coal mined. Fortunately, China has tremendous supplies of coal; but these will be of little value unless mining is modernized and the transportation facilities of the land are improved to enable the coal to be taken where it is needed.

Therefore a vast increase in China's railroad mileage is a necessity.

In another phase of the analysis, it is made clear that China's agricultural production, and hence her basic living standard, cannot be improved unless the average size of farms is increased from about 4 to about 13 acres apiece. The larger farms could then be worked by more modern methods and equipment, with a higher productivity per worker. This, however, would mean moving 180,000,000 persons off the land, and that of course cannot be done except they be absorbed in a great expansion of industry and personal services.

All of these steps, so intimately tied together, will be rendered futile unless the nation learns to control her population growth. The chapter on Population Control is the first really constructive proposal along these lines the reviewer, for one, has ever seen. The problem is faced with real courage. Gerald Winfield proposes that efforts to save life by combatting infectious diseases be held in abeyance until by a combined program of obstetrical and pediatric care, the plain people can be shown that it is not necessary or desirable for them to have so many births, and come to welcome methods of birth control. *Only when the birth rate has begun to drop will it be safe to undertake measures to reduce the death rate.* This sounds harsh to humanitarian ears, but one may well ask why one should save a person from death by disease merely to allow him to starve.

These questions culminate in the need for education, which must be the prime mover if such interlocked problems are to be attacked with intelligence and wisdom. The final chapter brings in the fateful theme of political domination. With all its faults, the Kuomintang held out more hope for China to realize these goals than the Communists can possibly manage to do. This book is a superlative analysis that shows what might have been. It should be read by every thinking American, in spite of the mental depression that will follow.

BENTLEY GLASS

GIPSIES IN DENMARK. *A Social-Biological Study. Opera Ex Domo Biologiae Hereditariae Humanae Universitatis Hafniensis. Volume 5.*

By Erik D. Bartels and Gudrun Brun. Einar Munksgaard, Copenhagen. Kr. 12.– (paper). 180 pp. + 3 plates. 1943.

This excellent study of nine gipsy families in Denmark should serve as a future model of a genetic-social investigation carried out without the influence of national politics. The authors were asked by the public aid authorities of the City of Copenhagen to study the gipsy families and to determine as far as possible the parts played by heredity versus environment in determining the peculiarities of gipsy behavior.

The history of gipsies outside Scandinavia until about the year 1900 is traced in the second chapter. Language studies in 1775 revealed the original home of gipsies to be India. They were brought into Persia to serve as court musicians in the fifth century A. D. Gipsies wandered to Greece, the Balkans, and on up into Europe during the middle ages. Numerous unsuccessful attempts were made to colonize them. In centuries gone by, as is usually the case in present times, they earned what livelihood they could by serving as musicians, in circuses, as tinkers, horse traders, and dealers in handicrafts. Through a strict system of intermarriage, the language and customs of the gipsy tribes have been maintained for centuries. However, in recent times, admixture with settled groups, usually of a rather low social order, has taken place to a large degree, and has resulted in a mixed population.

Chapter III deals with a history of the problem of vagrants, aside from gipsies, with especial reference to Danish conditions. During the Middle Ages beggars, wandering friars, peddlers, ex-soldiers, and artisans were constantly on the road. A class of regular vagrants arose in Denmark, probably from executioner's men, ex-soldiers, and their women. This group, called "nightmen," earned a living scavenging in the towns, removing the carcasses of animals dead from accident or disease, gelding horses and boars, and chimney-sweeping. This group has now been successfully absorbed into honest, settled populations in Denmark, with apparently no ill effects upon the latter.

In Chapter IV the history of gipsies in Scandinavia is traced. The exact time of entry of gipsies into Denmark is not known, but in 1512 a royal decree was issued banishing them. Stringent gipsy laws from the sixteenth to the eighteenth centuries in Denmark reveal a merciless persecution of this unfortunate group.

Chapter V is entitled "Gipsies in Our Days. What is Meant by a Gipsy?" and reviews an extensive investigation of gipsies in Germany by Ritter (1937). Unfortunately, this work seems hopelessly influenced by the theories of National Socialism regarding racial superiority and inferiority. Bartels and Brun view this work with somewhat more sympathy, but do take a firm stand against Ritter's claim that with an increase of gipsy blood, mixed gipsy children become more dark in hue and pari possu their intellect becomes more and more deficient. The German outlook on gipsies is exceedingly pessimistic, and upon mixed gipsies is even more gloomy. Ritter's latest work has indicated that the Germans were contemplating sterilization measures against gipsies. Ritter's own definition of a gipsy is an individual who has among his grandparents at least three gipsies. A mixed gipsy, then, is an individual who had among his grandparents either one or two pure gipsies or at least two quarter or half gipsies. The Danish authors make use of these definitions in their study.

In Chapter VI the history and mode of living of

modern Danish gipsies is discussed. The nine families which form the object of this study emigrated from the northern part of Germany, mostly from Schleswig and Holstein, between 1800 and 1850. Their mode of living resembles that of their ancestors. Their occupations include the fair business, running merry-go-rounds or swing boats. Some are artistes, a few being at the top of their professions in circuses; some own circuses; others are street musicians, or vendors of things of their own making such as paper flowers. Another principal occupation is grinding, and minor mending. Danish Sanitary Laws allow traveling about in caravan wagons only in the summer months. Consequently a permanent winter establishment is maintained by many of the Danish gipsies.

Chapter VII summarizes the relations of the Danish gipsies to the public relief administration, and also to criminality. A great deal of public relief is expended upon the gipsies. On the other hand, their contacts with the police are usually only the consequence of petty offenses. Not a single serious crime has been committed by any member of the nine families of modern Danish gipsies.

Chapter VIII discusses the racial composition of modern Danish gipsies. As the authors point out, their nine families, traced for six generations, now contain few pure gipsies. Most individuals are "mixed gipsies," and the entire group of from 700 to 800 persons will in time (estimated at 50 to 100 years) become assimilated into the native Danish population. The next chapter contains pedigrees and a detailed history of eight of the nine families studied. Such a detailed study could not be made of the ninth family, but it was known to resemble the others. These reports were made up not only from public aid records and school records, but also from careful visits to the homes and caravan wagons of the gipsies and long conversations with members of the family and with their neighbors. Far from being influenced by the pessimistic outlook on the gipsy problem taken by Norwegian and German authors, the Danish authors have preserved a true scientific impartiality in their investigations.

In the final chapter, the authors conclude that gipsies in Denmark do represent a "biologically delimited group within the population" because of (1) their foreign appearance (i.e., dark complexion, characteristic features), (2) their own feeling of being an entity separate from the native Danish population. Secondly, the authors believe Danish gipsies to be in general mentally sound. Bartels and Brun take exception to the views of Ritter that even mixed German gipsy populations possess a "special form of feeble-mindedness." The Danish authors state that the cultural background of the gipsy in general affects him in such a way that he completely lacks the inclination to adapt himself to a normal, settled, orderly existence. Thus he neither likes to stay long in one place nor to have permanent work. No great criminality exists among the Danish gipsies, though they are often guilty of small offenses because of their poverty and lack of education. The authors suggest that the peaceful and kindly conditions in Denmark may have some bearing on the low criminality among Danish gipsies, compared with the high number of criminal offenses found among them in Germany. The authors believe that it is not possible to change the Danish gipsies' way of life among those now living. They observe that the Danish gipsies are rapidly becoming assimilated into the native population, and state that "although the gipsy families cost the community a considerable sum of money," they are "no danger to public security." The authors are firmly opposed to Ritter's advocacy of sterilization of all individuals displaying asocial behavior. From the point of view of eugenics, Bartels and Brun point out that the gipsy families have shown that they are capable of fostering citizens who are just as good as the the average of the population. They suggest that gipsies in their capacity as entertainers and owners of circuses have performed a service to small isolated villages.

The reviewer is impressed with the spirit of kindliness and scientific honesty with which this investigation has been carried out at a time when Denmark was occupied by the Germans. The study of Danish gipsies is thorough to the smallest detail. Upon reading the case histories, one feels the greatest admiration for the complicated system of Public Aid which one learns must exist in Denmark. Such a system, carried out with patience, is designed for helping the indigent individual to help himself. Excellent photographs of various Danish gipsies are included at the end of the monograph. The monograph is written in practically faultless English.

SARAH BEDICHEK PIPKIN

MALE AND FEMALE. *A Study of the Sexes in a Changing World.*

By Margaret Mead. William Morrow & Company, New York. $5.00. xii + 477 pp. 1949.

The author has tried to find out what the differences between the two sexes actually are, in order to build a better society on such knowledge. She here confirms her earlier findings that most of these differences are social conventions, built up in childhood, a developmental stage to which she has always attributed an exclusive importance for character formation. Miss Mead goes again over the seven South Sea cultures she has observed, and in examining the formation of males and females there she has discovered, besides the well known anal, oral, and other types of sex behavior delineated by Sigmund Freud, a new one, the womb envy of males. The basic thing in females is their ability to bear children, while men, according to the author, are eternally uncertain of their ability to

perform sexually and of their fatherhood, which makes them more aggressive, active, etc. The author also makes some comments on the relations of sexes among the people of the United States, the difficulties of bringing up girls like boys and then making housewives of them, etc.

This book will be a disappointment to those who have liked the author's earlier monographs, which were indeed always subjective, but also lively and stimulating. These 500 pages of very involved writing seem to lead nowhere but to the few not very helpful generalities mentioned above. It might be suggested that this sad result has something to do with Margaret Mead's particular anthropological methods, which she explains, lauds, and defends at great length. They seem not to be very adequate in reaching valid theoretical and practical generalizations, especially when applied to the more complex non-tribal societies.

ERWIN H. ACKERKNECHT

FROM CAVE PAINTING TO COMIC STRIP.

By Lancelot Hogben. Chanticleer Press, New York. $5.00. 287 pp.; ill. 1949.

If man is unique, concludes the author, it is because he is "the only picture-making animal which has ever lived on our planet." Nothing else about him is more than an extension of features found in other animals. With copious and excellent illustrations, the pictorial strand is followed from some 30,000 years ago to the present day. Careful consideration is given to the relationships of totemistic signs, zodiacal portents in relation to agriculture, alphabets and modes of counting, paper-making, playing cards, and movable type. Hogben traces the shift of centers of civilization northward and shows how cloudy weather plus winter cold make understandable the new interest in the technology of glass-making—and its products, such as clear window glass, lenses, and eyeglasses. He points to the standardization of spelling and grammar which followed the introduction of printing, and to the development of the international symbolisms that have grown up in electronic circuit representations, in floral diagrams, and atomic detail. As a culmination in this direction, Hogben praises at length the universal picture language begun by Otto Neurath in 1925 in Vienna, and called "Isotype";—the present "book is a tribute to his memory." Printers' ink, vanishing points, map making, color printing, and improvements in press design bring the subject to modern times and a carefully documented analysis of the American comic strip, with the frustrations of everyday life found to be the clue to its appeal. The book ends with a plea for early adoption of an international language and for an acceleration in the training of world citizens through wall charts, motion pictures of improved types, and other visual aids—with emphasis on such universally understood symbolism as Neurath's Isotype.

The book is handsomely presented, but the choice of Monotype Poliphilus, with its slanted hyphens and stylized numerals, makes for slower reading. On a page with phonetic symbols a Poliphilus 5 is not identified as easily as a familiar 5. The captions for the illustrations, in many instances, are confusing in their departure from the conventional sequence, the reader being guided first to the figure in the lower corner of the right-hand page, then to the lower left, then the upper right, next middle left, and so on. In a book subtitled, as this one, "A Kaleidoscope of Human Communication," with such excellent illustrations of the best of cave drawings and of modern color photography, it seems that a more valiant effort might have been made to use the best of type faces and a more customary sequence in the captions.

LORUS J. & MARGERY J. MILNE

BIOMETRY

INTRODUCTION TO THE THEORY OF PROBABILITY AND STATISTICS. *Wiley Applied Mathematics Series.*

By Niels Arley and K. Rander Buch. Edited by I. S. Sokolnikoff. John Wiley & Sons, Inc., New York; Chapman and Hall, Limited, London. $4.00. xii + 236 pp. 1949.

This, the second book in Wiley's newly-created Applied Mathematics Series, is a translation of the third edition of a Danish text. The senior author is an assistant professor of physics in the Institute for Theoretical Physics at the University of Copenhagen, the junior author an assistant professor of mathematics in the Institute for Applied Mathematics at the Denmark Institute of Technology. According to the authors, the purpose of the book is to provide an elementary introduction to the theory of probability and statistics, with special emphasis on practical applications. It appears to have been aimed at a broad audience including students in physics, biology, engineering, and other sciences. Examples are selected from such diverse fields as ordnance, telephony, theoretical physics, and actuarial science.

American students in biology will find this a high-level textbook despite the word "Introduction" in the title. In order to understand all beyond the first three chapters, the student should have a background in calculus, linear equations, and the theory of matrices. One feature of the book which, in the reviewer's opinion, makes it thoroughly unsuited for an English audience is the entirely new system of symbols and notations the authors introduce. English-speaking statisticians and biometricians have long deplored the lack of any consistent system of notation in the field. This, more than anything else, is a source of serious annoyance

and confusion for the student. At least certain terms however, seem to have been reasonably well standardized in most English and American texts. Among these are r (the correlation coefficient), p (probability that an event will happen), q (1-p), and F (the ratio between variances). Variants of other symbols, not so well agreed upon (for degrees of freedom, mean, and variance, for example), are at least familiar to many students of statistics. All these familiar cues are lost in this book. The almost universal F is replaced by w^2, r has become ρ, p has become θ, degrees of freedom are symbolized by f, and so on. In fact, a student trained on this book alone would almost certainly not be able to understand the statistical terminology used in current scientific literature.

A. CHAPANIS

ANALYSIS AND DESIGN OF EXPERIMENTS. *Analysis of Variance and Analysis of Variance Designs.*

By H. B. Mann. Dover Publications, Inc., New York. $2.95. x + 198 pp. 1949.

This book—one of the Dover Series in Mathematics and Physics—is about the analysis of variance and the analysis of variance designs as statistical procedures. The contents provide a complete, although brief, coverage of the field. Starting with the chi-square and F distribution functions, the textbook then discusses the analysis of variance in one-way and *r*-way classifications, Latin squares, orthogonal Latin squares, incomplete balanced block designs, factorial designs, randomized designs, the analysis of covariance, and many other topics.

This is a book by a mathematician (the author is Professor of Mathematics at the Ohio State University) written for mathematicians. Its goal is to provide a rigorous mathematical treatment of the subject. The author has gone far toward achieving this objective but, in so doing, he has written a book far beyond the practical experimenter. The discussion is entirely at symbolic level, with no illustrative examples, problems, or guides to computational procedures. In short, this text is for professional statisticians and mathematicians. The biological scientist had best look elsewhere for help on analysis of variance designs.

A. CHAPANIS

DE OMNIBUS REBUS ET QUIBUSDAM ALIIS

GIANT BRAINS.

By Edmund Callis Berkeley. John Wiley & Sons, Inc., New York (Chapman & Hall, Limited, London). $4.00. xi + 270 pp. 1949.

Surely everyone has by now read in newspapers and magazines about fabulous computing machines which are so fast and so complex that they stagger the imagination. Not only do these machines perform extraordinary feats of calculation (the ENIAC, for example, can do 5000 additions a second), but they also make decisions, choose between different courses of action, learn, remember, and determine most of their own instructions. These machines are the subject of *Giant Brains.*

The author starts with the query, Can Machines Think? and in the first chapter he compares, point by point, the characteristics of human thinking with the kinds of operations mechanical brains can perform. The second chapter considers and classifies various systems for handling information. Chapter 3 shows in detail the principles on which a simple mechanical brain can be constructed. The next six chapters describe several existing large-scale mechanical computers, including a "thinking" machine called the Kalin-Burkhart Logical-Truth Calculator. The final three chapters look to the future, speculating about machines now in the design stage and the effects that they will have on our future society.

If you have any curiosity at all about these gadgets, you will find this a fascinating book. It is written by an expert in the field and so is authoritative. This last sentence, however, should not frighten the reader because this book is a model of what can be done to make difficult material comprehensible. It is excellently written and even if you understand little or no mathematics, you will find here much to excite your interest.

A. CHAPANIS

FORGOTTEN MYSTERIES.

By R. DeWitt Miller. Cloud, Chicago. $2.50. xiv + 202 pp. 1947.

The mysterious and the inexplicable have always been intriguing, even when accompanied by distrust, apprehension, or muttered prayer. They also serve, to some, as a reminder that science is not infallible and all-knowing, and that the embracing arm of faith is comforting indeed when footsteps sound on the stairs, or the phantom barkeep puts in his appearance. The author has gathered together these tales for the curious, the scoffers, or the believers, and with no other intent except to say "Here they are; make of them what you will." Included are the poltergeists, phantom armies, deserted ships, and sea serpents, to mention a few of the varied mysteries. The book was published too early to include the flying saucers of recent days. Many of the tales are well documented. Some undoubtedly lend themselves to psychological explanation, others to no logical solution. All make interesting tales for a dark and rainy night.

C. P. SWANSON

NO PLACE TO HIDE.

By David Bradley. An Atlantic Monthly Press Book, Little, Brown and Company, Boston. $2.00. xviii + 182 pp. 1949.

BOMBS AT BIKINI. *The Official Report of Operation Crossroads.*

By W. A. Shurcliff. Wm. H. Wise & Company, New York. $3.50. x + 212 pp. + 33 plates. 1947.

Between them, these two books give a clear picture of the Bikini tests of the atomic bomb in 1946. Bradley's book conveys the vivid impressions and the psychological impact of the events on an observer. The official report, however, gives far more detailed and precise information about the tests, including the effects upon exposed animals and plants. (The study of genetic effects is barely mentioned, however, and is limited to mice alone, although the report on hereditary effects induced in maize seeds has by now been reported in *Genetics*, 34: 639–646. 1949.) Somehow—for a scientist, at any rate—the implications of the bomb for the future of human civilization strike one more forcefully in reading the simply stated facts of the official report than in all of Bradley's vivid narrative.

BENTLEY GLASS

ELECTRON MICROSCOPY: *Technique and Applications. By Ralph W. G. Wyckoff. Interscience Publishers, New York and London.* $5.00. x + 248 pp.; ill. 1949.

In comparison with the optical microscope, the electron microscope provides an extension of sight into the invisible world comparable to that which the optical microscope gave to the unaided eye. Refined techniques can now resolve particles less than 20 Å in diameter. Since the author has been actively engaged in perfecting techniques which have extended the usefulness of electron microscopy, and since he has contributed, in prior years, to the development of radiation biology in general, he is well suited for the task of assembling a textbook which deals with the techniques and applications of the instrument. Microbiologists in particular will find ample material related to their studies. The chapters are well supplied with references. Wyckoff does not confine himself to biological subjects, however, for the application of the microscope to metallurgy and chemistry is fully covered.

Biologists will find the last four chapters (7–10) of particular interest, inasmuch as they deal with the electron microscopy of bacteria, viruses, and macromolecules such as hemocyanin, globulin, cellulose, collagen, and the like. The photographs are exceptional in their clarity. The earlier chapters cover the historical development and the physics of the instrument, together with the techniques used in the preparation of specimens.

As the author has emphasized, the full potentialities of the electron microscope have not yet been realized. This is understandable when one considers that its first use dates from 1931, and that several centuries of work have gone into the development of the optical microscope. Science, however, was better prepared to exploit the usefulness of the electron microscope, and the text conveys the considerable information which its use has brought forth. It is to be hoped that the x-ray microscope, not yet perfected, will prove as flexible and as adaptable a tool.

C. P. SWANSON

PROCEEDINGS OF THE AMERICAN PHILOSOPHICAL SOCIETY *Held at Philadelphia for Promoting Useful Knowledge. Volume 92, Number 4.*

The American Philosophical Society, Philadelphia. $1.00 (paper). ii + Pp. 211–323; ill. 1948.

This number contains 7 papers on the Relation between International Affairs and the Traditional American Scene, presented at the Annual General Meeting April 22–23, 1948. In addition, it includes the annual R. A. F. Penrose, Jr. Lecture, on this occasion given by Robert B. Warren and entitled An Attempt at Perspective. Five other papers, on various topics, include the following 3 of biological interest: The Prehistoric Archaeology of Tangier Zone, Morocco (Hugh Hencken); An Unfamiliar Mechanism of Disease Transmission (Richard E. Shope); The Mechanism of Wounding by High Velocity Missiles (E. Newton Harvey).

SCIENCE NEWS—12, 13, 14.

Edited by J. L. Crammer. Penguin Books, Harmondsworth, Middlesex. 1s. 6d. each (paper). (12) 160 pp. + 16 plates; text ill.; (13) 162 pp. + 10 plates; text ill.; (14) 160 pp. + 16 plates; text ill. 1949.

Among the articles in these three issues of *Science News*, the following are biological in nature: (12): The Light of Glow-Worms and Fire-Flies (V. B. Wigglesworth); Infectious Diseases and the Country Doctor (W. N. Pickles); Agene and your Bread; Viruses (K. M. Smith); Farming Front (R. N. Higinbotham); Micro-climates (Amyan Macfadyen). (13): Chromatography (E. Lester Smith); The Problem of Cancer (E. C. Dodds); Ancient Peoples of the Andes (G. H. S. Bushnell); Experimental Embryology Today (Michael Abercrombie); Population Problems of India and Pakistan (S. Chandrasekhar); Chloromycetin; Analysis of Psychological Fields (John Cohen). (14): The Discovery of the Bacteriophage (F. W. Twort); The Bacteriophage (Felix d'Herelle); The Nature of the Bacteriophage (Ralph W. G. Wyckoff); Viruses and the Veterinary Surgeon (G. P. West); Molecular Architecture in Plants (R. D. Preston); The Electrical

Activity of the Human Brain (William A. Cobb); Synthetic Fibres (R. W. Moncrieff). Number 13 includes, for the first time in the series, a number of fine color plates, illustrating the article on chromatography. In Number 14, the plates have been changed from rotogravure to half-tone engravings, printed on excellent paper. The historical series on the bacteriophage is particularly noteworthy. In all respects this little popular journal of science is proving its worth and improving its content.

BENTLEY GLASS

CARNEGIE INSTITUTION OF WASHINGTON YEAR BOOK NUMBER 47, JULY 1, 1947–JUNE 30, 1948. *With Administrative Reports Through December 10, 1948.*

Carnegie Institution of Washington, Washington, D. C. $1.00 (paper); $1.50 (cloth). xxxvi + 235 pp. + 5 plates; text ill. 1948.

In the current *Year Book* summaries and advance reports of work of a biological nature are those from the Division of Plant Biology, the Departments of Embryology and Genetics, and the Special Project of Ross G. Harrison. In the first of these, besides the continuation of the work on the photochemical activity of isolated chloroplasts, chlorophyll formation, and the occurrence and properties of chloroplast pigments, a very interesting report on the alga *Chlorella* as a source of food has been added. Genetic analysis of climatic races of *Potentilla glandulosa* and of the results of the selection experiment carried on at 3 transplant stations at different altitudes since 1938 represents a continuation of highly significant work in plant ecological evolution. Ralph W. Chaney has reported his interesting study of a living species of *Metasequoia* found to be living in China, although the genus was supposed to have been extinct since the Miocene.

At the Department of Embryology studies have been carried on upon: the length of the period in pregnancy during which the corpus luteum is necessary (Corner); the development of accessory reproductive organs in hamsters (Faith W. Lavelle); migration of the human germ cells (Witschi); development of the human testis and ovary (Gillman); development of the diaphragm (Wells); development of the vertebrae (Sensenig); development of the cranial arteries (Padget); the mammary gland of the monkey (Speert); spiral arteries in the human ovary (Reynolds); growth of the pregnant uterus in the rat (Bradin); structure of the uterus in relation to menstruation (Kaiser); physiology of endometrial grafts (Kaiser); physiology of the uterus and development of a tokodynamometer (Reynolds); effects of anti-histaminics on the uterus (Reynolds & Kaiser); the source of fetal iron (Flexner); permeability of the the human placenta to sodium (Flexner et al.); and the physiology of the eye (Flexner et al.). The contribution to the achievements of the Department of Embryology made by guests and outside collaborators has been very considerable and marks the widening influence of this group of biologists.

At the Department of Genetics, Kaufmann has made further studies of the action of purified ribonuclease and pepsin on chromosomes, and also chemical studies of amphibian nuclei. Work on the genetic effects of infrared radiation and on the non-homologous associations of salivary gland chromosomes of *Drosophila* has been continued. McClintock's investigations of the effects in maize of a specific activator locus, which causes various loci in the short arm of chromosome 9 to become unstable, have led to new and quite startling genetic concepts. The high mutability appears to be due to a gain by one chromatid of something lost by its sister chromatid, bringing about an increase and decrease, respectively, of identical genetic units present in a reduplicated state within a locus. Demerec and his coworkers have continued their extensive investigations of the mutagenic potency of carcinogens and related compounds, of the chemical induction of mutations in bacteria, and of population dynamics in bacteria. Doermann has contributed a highly important study of the intracellular growth of bacteriophage, using sonic vibrations to disrupt the bacteria at various stages after their infection with phage. Caspari and Richards have studied the action of the gene *a* in *Ephestia* on tryptophane metabolism, and have also analysed a case of pseudoalleles in the mouse. MacDowell and his group have now freed the line of mouse leukemia they have studied from all the associated virus, and consequently have been able to analyse the effects of virus and leukemia separately and in combination. Dobzhansky has confirmed the existence of adaptive polymorphism in *Drosophila pseudoobscura* dependent upon upon different inversions which within populations become coadapted through natural selection, although the same inversions from different populations show no coadaptation. Harrison has summarized his studies on the origin, development, and growth of the forelimb in *Amblystoma*. In the development of the limb, the mesoderm plays the dominant role and the ectoderm a very subsidiary one.

BENTLEY GLASS